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29 January 1980

USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 66

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 66

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BRIEFS

ALUMINUM PRODUCTION--The output of aluminum at the Tadzhik Aluminum Plant was increased almost one-third. New production has become operational here. Modern technology permits not only a reduction of the specific electric power consumption, but also provides high purity of the metal. The plant--the head enterprise of the Southern Tadzhik Territorial Industrial Complex--continues to the expanded. An additional large shop is now being prepared for installation. [Text] [Moscow EKONOMICHESKAYA GAZETA in Russian No 49, Dec 79 p 6] 6521

[54]

SUPERPURE ALUMINUM--Dushanbe--The first tens of kilograms of superpure aluminum have been produced at the Institute of Chemistry of the Tadzhik Academy of Sciences. It contains only 0.0005 percent microimpurities. The new metal is qualitatively produced by the multiple recrystalization method. And the raw material was the "winged metal" smelted by the Tadzhik Aluminum Plant. The scientists of Tashkent, reported Vice-President of the Academy of Sciences of the republic P. Solozhenkin, are working on the problem of increasing the output of metals of special purity. [Text] [Moscow IZVESTIYA 3 Nov 79 p 3] 6521

[54]

USSR UDC 669.71:539.37

THE EFFECT OF ADDITIVES ON THE SUPERPLASTICITY OF ALUMINUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48 No 1, Jul 79 pp 194-196 manuscript received initially 29 Mar 78, in final form 21 Jun 78

KUZ'MIN, S. L., LIKHACHEV, V. A., MYSHLYAYEV, M. M., NIKONOV, YU. A., and SEN'KOV, O. N., Leningrad State University imeni A. A. Zhdanov

[Abstract] The aluminums tested included technically pure (99.5%) and pure (99.999%) aluminum, and duraluminum with 4.1% Cu, 1.5% Mg, 0.6% Mn, 0.5%, 0.5% Si, 0.3% Zn and up to 1.5% other impurities. Samples were subjected to torsion and tension was measured by electron microscope. The results showed that in pure and technically pure aluminum grain size was not affected by torsion, and monocrystals and polycrystals showed similar superplasticity. A decrease in the size of structural elements decreased the degree of deformation before failure. Figures 3; references 7: 5 Russian, 2 Western.
[31-12131]

USSR UDC 669.71'721'5

OPTIMIZATION OF THE COMPOSITION OF THE Al-Mg-Zn CASTING ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, 1979 pp 41-42

DOLZHANSKIY, YU. M., POSTNIKOV, N. S. and POBEZHIMOV, P. P., All-Union Scientific Research Institute of Aviation Materials

[Abstract] Al-Mg alloys have been used as corrosion-resistant materials in marine environments. The addition of Zn to the system permits the development of a single phase -solid solution. This increases the strength characteristics and allows a reduction in the light elements to (Mg+Zn) $\leq$ 10%. Additions of traces of titanium, manganese, and beryllium improve the structure, decrease the susceptibility of oxidation, and increase the mechanical properties. A mathematical model was set up to study the changes in mechanical properties (Y_i) as a function of the % Zn (X_2) and % Mg (X_1). Values of X_1 ranged from 6 to 11%; and those of X_2, from 0.5 to 3.5%. The alloy also contained 0.1% of Ti, Mn, and Be. The optimum mechanical properties ($\sigma_B \simeq 40$ kg/mm^2, $\sigma_{0.2} \simeq 30$ kg/mm^2, and $\delta \approx 10\%$) were obtained for 6 to 8% Mg and 1.5 to 3% Zn. Figures 2; references 6 (Russian).
[26-12027]

USSR UDC 669.715

CREEP AND HEAT RESISTANCE OF ALUMINUM ALLOYS FOR PISTONS

Lvov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15 No 5, 1979 pp 105-106 manuscript received 30 Nov 78

CHERNOV, V. YU., LENTS, R. O., BONDAREV, A. A. and RABKIN, D. M., Institute of Electrical Welding imeni Ye. O. Paton Academy of Sciences SSR, Kiev

[Abstract] Creep in Silumins was determined at 260, 300 and 360° C; these temperatures were regarded as typical for the area of the first compression ring and the combustion chamber. Samples of AL25 and AL30 aluminum alloys were prepared, age hardened for 12 hours, then subjected to temperature and load variables. No variations in creep for the two alloys was noted. Less stretch (1.5-3%) was recorded at 260 and 300°C (11-13%). The rate of oxidation also was related to temperature variations. Figures 2: references 2 (Russian).
[42-12131]

USSR UDC 620.178.2:669.725:620.184.6

ON THE QUESTION OF DETERMINING THE FRACTURE DUCTILITY OF BERYLLIUM USING DATA OF FRACTOGRAPHIC INVESTIGATIONS

Lvov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15 No 5, 1979 pp 82-86 manuscript received 21 Mar 77

KANCHEYEV, O. D. and POLITIKO, S. K.

[Abstract] To study practical problems relating to the coefficient of fracture ductility, hot-extruded rods of distilled and technical metal-beryllium containing about 0.9% O_2 and no more than 0.3 to 0.5% metallic impurities were tested for fatigue at a frequency of 2000 cycles/minute in a compression-stretching cycle based on $1 \cdot 10^6$ cycles. Fractographic analysis showed that in the temperature range of -196 -- +300°C, unstable growth of cracks was related to the development of macrofacets. Crystalline defects developed in the material during the course of fatigue tests, bringing a reduction in the coefficient of fracture ductility. At temperatures above 300°C the nature of defects changed from transcrystalline to intercrystalline. Further experimental data are necessary to establish a correlation between results of fractographic analysis and other tests. Figures 5; references 12: 6 Russian, 6 English.
[42-12131]

BRIEFS

STEEL PARTS PRODUCTION--The electrode approaches the steel part, a dry crackle is heard and thousands of fiery filament discharges occur on the surface of the article. The temperature reaches 10,000 degrees within a second. The steel becomes darker before one's eyes, being covered with a thin layer of solid compounds. The metal is bombarded by "mini-lightning" by a device developed by scientists of the Institute of Problems of Materials Science of the Ukrainian SSR Academy of Sciences, the Institute of Applied Physics of the Moldavian Academy of Sciences and the Penza Polytechnical Institute. These "mini-lightnings" are capable of splitting a molecule of one material and of tightly "stitching" them to the surface of another. Since the refractory compounds used as the electrodes are distinguished by especially high hardness and wear resistance, ordinary steel acquires a reliable coating. As indicated by practice, it increases the durability of steel parts by a factor of 3-4. [Text] [Moscow SOVETSKIY VOIN in Russian No 14, Jul 79 p 47] 6521

[54]

USSR UDC 621.762

THE EFFECT OF SATURATION AND THERMAL AGING ON THE INSULATING PROPERTIES OF ALUMINUM OXIDE PLASMA COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 39-42 manuscript received 30 Oct 78

KARPINOS, D. M., DMITRIYEV, V. S. and ZIL'BERBERG, V. G., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] Local delamination, cracking and destructive isolation experienced with previous electrical isolation methods led to the development of a method of plasma deposition based on a 150-200 mkm layer of aluminum oxide. The surface was first roughened with metal shot, then saturated in a vacuum with ceramics and corundum, orthosilicic acid with corundum, and an orthosilicate material. Results showed good adhesion qualities using this method after prolonged thermal action and a series of heating and cooling applications of 20-859-20° C at 5-5.5 degree/minute. Figures 4; references 6: 5 Russian, 1 English.
[43-12131]

USSR UDC 539.216.1

EFFECT OF BRITTLE COATINGS ON THE STRENGTH OF BORON FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 79 pp 82-86 manuscript received 14 Feb 78

USTINOV, L. M., Moscow

[Abstract] An analysis was made of the effect of SiC, B_4C and BN coatings as well as brittle layers in AlB_2 and TiB_2 composites on the strength of boron fibers and the nature of change of the coatings. Boron fibers coated with the first three coatings should fracture with a critical thickness of 1--2 microns (SiC, B_4C) and tenths of a micron (BN). The critical thickness for the brittle layers in combination with boride fibers was equal to tenths and even hundredths of a micron. The relationship of borsic (B-SiC) fibers (boron coated with SiC) to coating thickness was established and found to be satisfactory with the theoretical relationship to the critical thickness of SiC being 1.5 microns. Figures 2; references 9: 4 Russian, 5 Western.
[25-6368]

USSR UDC 669.058:669:293

APPLICATION OF TITANIUM CARBILE COATINGS TO IRON AND STEEL SURFACES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 10, 1979 pp 35-37

LOSKUTOV, V. F., BYAKOVA, A. V. and SAPON, V. I., Kiev Polytechnic Institute

[Abstract] Considering that carbide coatings enhance hardness and resistance to wear and corrosion in steel products, the vacuum deposition of titanium carbide coatings on the surface of 15 x 10 x 15 mm specimens of Armco iron and 20, 25, U8A, and U12A carbon steels was experimentally investigated. The process was carried out in the presence of CCl_4, granules of polyethylene, and pure titanium powder (200 μm grain size) at 10^{-1} mm Hg. The CCl_4 was added because at high temperatures it dissociates into carbon and free chlorine: the chlorine interacts with the Ti powder to form gaseous chlorides, thus assuring delivery of Ti atoms to the specimen surface. Granules of polyethylene were added to increase the carbonizing power of the mix. The optimal amounts of polyethylene and CCl_4 were found to be 5 g and 5 cc, respectively, per square meter of the area saturated, inclusive of the interior surface of the reaction chamber. The optimal temperature and time of deposition were found to be 950-1000°C and 3-5 hrs, respectively. The wear resistance of the products so coated was found to be 3-7 times as high as that of the non-coated products. Hardness and corrosion resistance (in 3% NaCl, 10% Na_2CO_3, 30% KOH, and 0.1 n.H_2SO_4 solution) also were then greater. Figures 2; references 8 (Russian).
[23-1386]

USSR UDC 621.357.7

ON THE INCLUSION OF CERAMIC MICROPOWDERS IN NICKEL COATINGS. REPORT 6: EFFECT OF FINE-DISPERSE PARTICLES ON THE STRUCTURE OF CERNIK COATINGS

Vil'nyus TRUDY AKADEMII NAUK LITOVSKOY SSR in Russian, Ser B No 5(114), 1979 pp 29-34 manuscript received 10 Apr 78

RAMANAUSKENE, D. K., YURYAVICHENE, M. I. and SKROBOTSKAYA, V. V., Institute of Chemistry and Chemical Technology, Academy of Sciences Lithuanian SSR

[Abstract] Microparticles of electrocorundum (α-Al_2O_3), boron carbide (B_4C) and silicon carbide (SiC) were included in a nickel coating matrix, for a comparative study of the embedment kinetics and the resulting cernik

structure. Examination under a JEM-5Y electron microscope and electronographic analysis, with single-stage carbon replicas and palladium shading produced in a vacuum apparatus, indicate that the embedment mode depends on the electrical properties of the inclusion material. The morphology of a nickel matrix is altered by microparticles with an electrical surface activity (SiC) and even more so by microparticles with some electrical conductivity (B_4C), by way of ingrowth with formation of crystallite clusters which inhibit the growth of oriented nickel crystals and increase the surface roughness. Figures 3; references 16: 6 Russian, 10 Western.
[53-2415]

USSR UDC 628.357.7

CAUSES OF INTERLINKAGE BETWEEN Ni-SiC COATINGS AND AN ALUMINUM ALLOY

Vil'nyus TRUDY AKADEMII NAUK LITOVSKOY SSR in Russian, Ser B No 5(114), 1979 pp 21-27 manuscript received 21 Mar 78

FROLOVA, F. P., ZHITKYAVICHYUTE, I. I. and MIKAYLENE, YE. S., Institute of Chemistry and Chemical Technology, Academy of Sciences Lithuanian SSR

[Abstract] A study was made of the effect of heat treatment at 200°C for up to 200 hours on cast AK18 aluminum alloy with a zinc undercoating on the etched surface and with two nickel overcoatings, the preliminary nickel layer having been deposited from a special-purpose electrolyte and the elastic final nickel layer having been deposited from a Watts electrolyte first containing and then without any disperse particles of silicon carbide. Microsections of the resulting 5-layer (Al, Zn, Ni, Ni-SiC, Ni) specimens were structurally examined under a Neophot-2 optical microscope, with an EP-100 electronograph (in both "transmission" and "reflection" modes), and with a JXA-50 x-ray microanalyzer. Furthermore, the distribution profiles of all three metals were determined and the bond strength between coating and base metal was measured in a tensile testing machine. The results indicate that heat treatment causes interdiffusion of all three metals and formation of solid solutions, especially during the first few hours. Prolongation of the heat treatment does not enhance the bond, but oxidation of the zinc layer prior to deposition of nickel coatings causes a decrease in the final bond strength. Figures 4; references 7 (Russian).
[53-2415]

USSR UDC 621.793.7.001

ADHESION STRENGTH OF DETONATION COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 79 pp 79-83 manuscript received 19 Oct 78

KORNEV, A. D. and LIVSHITS, M. I., Dnepropetrov Chemical Technology Institute

[Abstract] The effect of horizontal, vertical and radial movement on the adhesive strength of coatings applied by the detonation method was studied. Three experiments were carried out where in one the horizontal and vertical movements of a cassette containing the samples being coated were studied. In the second experiment the effect of rotary motion was studied and in the third one the parts being coated were stationary. Results showed that the third experiment produced by best coatings because in the first two experiments the motion of the samples caused the coatings to have a peripheral zone with weak bonding strength. Figures 2; references 4 (Russian).
[24-6368]

USSR UDC 669.014.018.96:669.295'71'28'296:546.281.261

INVESTIGATION OF THE STRUCTURE AND PHASE COMPOSITION OF THE INTERACTION ZONE IN A VT9 TITANIUM ALLOY-SILICON CARBIDE FIBER COMPOSITE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 9, Sep 79
pp 1668-1671 manuscript received 21 Sep 78

Zaytsev B. G., GUZEY, L. S., SOKOLOVSKAYA, YE. M. and SHULEPOV, V. I.,
Moscow State University imeni M. V. Lomonosov

[Abstract] Results are presented from studying the structure and phase composition of the zone of interaction (ZI) in a composite made from VT9 titanium alloy and SiC fibers which was produced by hot pressing of a mixture of the granulated alloy and fiber at 950-970°C. The ZI was found to contain the same phases that are present in the Ti-Si phase diagram: $TiSi_2$, TiSi and Ti_5Si_3. When the composite was annealed at 800-1200°C, it was noted that the growth rate of the Ti_5Si_3 phase increased from a ratio of 1:1, with the $TiSi_2$ phase, to 2:1 at 1200°C. The mechanism of SiC fiber interaction with the Ti-base matrix was deduced to be the fact that the content of alloying elements in the VT9 was small whereupon these elements, with the exception of Zr, had a lesser affinity for carbon and silicon then titanium. Therefore the interaction of SiC with the matrix was mainly determined by its interaction with Ti. With carbon being the most mobile element, at the instant of interaction in the matrix zone a layer of TiC is formed next to the fiber. Then as Si and C diffuse through this layer, the more stable TiC will be enlarged as carbon causes the layer to increase in thickness while the silicon penetrates deeper into the ZI by diffusion to form silicide phases. Figures 1; references 16: 7 Russian, 9 Western. [49-6368]

USSR UDC 532.6

USING THE ION BOMBARDMENT METHOD TO ENHANCE THE ADHESION OF METAL FILMS TO THE SURFACE OF A GLASS-CARBON COMPOSITE MATERIAL

Moscow IVUZ. CHERNAYA METALLURGIYA in Russian No 7, 1979 pp 100-102
manuscript received 30 Oct 78

DIGILOV, M. YU., KOSTIKOV, V. I. and PAVLOV, YU. A., Moscow Institute of Steel and Alloys

[Abstract] Ion bombardment drives recoil atoms of the film material into the substrate, thus forming a transition layer. Considering that most metal coatings adhere poorly to carbon materials, the possibility of using this method to assure firm coating of the SU-1500 glass-carbon composite (GCC) was investigated. Specimens of GCC were annealed in vacuo at 3000°C and vacuum-sprayed with films of tin, molybdenum, and silver in a VUP-5 type vacuum chamber with a nitrogen trap in a vacuum of $5 \cdot 10^{-5}$ mm Hg. They were then bombarded with P^+ ions in a vacuum of $4 \cdot 10^{-6}$ mm Hg (ion energies 150-200 keV, doses 10^{12}-10^{16} ions/cm^2). Needle-scratch tests demonstrated that, compared with unbombarded specimens, the strength of adhesion of the coatings on the ion-bombarded specimens was tens of times greater. This is apparently due to the formation of a transition zone between the metal coating and the GCC, owing to: 1) penetration of substrate by the film's recoil atoms colliding with the bombarding ions; and 2) the accelerated diffusion of film atoms into the substrate owing to the radiation defects caused by the bombardment. Figures 2; references 6: 3 Russian, 3 Western.
[177-A--1386]

USSR UDC 669-494:669.295

ON THE SELECTION OF A TITANIUM MATRIX FOR COMPOSITE MATERIALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 79 pp 132-135

CHUNIKHINA, L. L., GUZEY, L. S. and SOKOLOVSKAYA, YE. M., Moscow

[Abstract] A study was made of the simultaneous effect of alloying a titanium matrix with aluminum, molybdenum and zirconium on the rate of interaction of these alloys in a titanium alloy-silicon carbide fiber composite. After the composite had been produced by hot pressing in a vacuum at 850-1200°C under a pressure of 10 MH/m^2 there was no detectable

transition zone. Micro-x-ray spectral analysis also showed no reaction zone. Samples were then isothermally annealed at 1200°C (0.5, 2 and 8 hours), 800°C (50, 200, 700 and 1000 hours) and 600°C (350 and 1200 hours). At 600°C the incubation period starts after 350 hours. At 800°C an intermediate reaction zone builds up after 200 hours at a thickness of 2--3 microns. In 700 hours this zone width is 3.5--6.5 microns thick. Equations are provided to show the width of the reaction zone after treating at 1200°C. It was determined that increasing the concentration of alloying elements, while staying in the alpha+beta-region slows down the matrix-fiber interaction very little so that in selection of matrix composition special attention should not be given to the rate of interaction but to the mechanical and physical properties of the investigated composite. Figures 2; references 10: 7 Russian, 3 Western.
[25-6368]

USSR UDC 622.32.658.58.004.18

INCREASING THE DURABILITY OF COMPOSITE MATERIALS WITH A GRANULAR TUNGSTEN CARBIDE BASE BY THERMAL HARDENING

Lvov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15 No 5, 1979 pp 95-97 manuscript received 11 Jan 78

BELOUSOV, V. YA., Ivano Frankovsk Institute of Petroleum and Gas

[Abstract] To explain the phenomenon of declining durability after tempering in water as temperature increases, phase analysis of the components of the MNMTS-60-20-20 alloy was made with samples tempered at 600°C and aged at 400°C. Nickel and manganese content in the granules was 21 and 19% respectively, but at the boundaries 50-52% nickel and 30-32% manganese was found. A study of the mechanical properties indicated that the durability of the alloy increased after the segregation of the enriched nickel-manganese compound, which was complete after 8-12 hours of age hardening. Before selecting the material of the coating it is necessary to consider the load under which the coating will operate. Figures 3.
[42-12131]

USSR UDC 669-419:539.374

FEATURES OF CRACK DEVELOPMENT IN LAYER COMPOSITES AND THEIR EFFECT ON FRACTURE ENERGY CAPACITY

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 79 pp 120-124 manuscript received 21 Apr 79

GUZ', I. S., MILESHKIN, M. B. and GAZOV, V. I., Khar'kov

[Abstract] Results are presented from an investigation of the kinetics and micromechanism of fracture during the impact bending of a crystallized eutectic Ni_3Al-Ni_3Nb and a 45 steel + M3 copper bimetal. In the eutectic composite crack propagation occurs mainly by three types: 1) at right angles to the plates with no traces of interphase fracture; 2) at right angles to the plates with the presence of small local stratifications; and 3) significant stratifications. For the bimetal there were four zones of fracture: 1) ductile fracture in the copper layer; 2) initial ductile fracture of the steel; 3) fracture at the bimetal interface; and 4) mixed fracture modes in the steel. The effect of stratification on fracture energy capacity of layer materials is more substantial when it leads to an increase in the work expended to bend the second layer and to a change in the fracture mechanism (increase in the work expended to fracture the second layer). In the nickel composite, multiple stratification did not yield any significant increase in impact strength. Figures 5; references 3 (Russian).
[25-6368]

SYNTHETIC CAST IRON PRODUCTION

Moscow EKONOMICHESKAYA GAZETA in Russian No 33, Aug 79 p 14

[Article by P. Mishin, director of the Experimental-Production Complex of NPO Tulachermet, S. Koshelev, chief engineer of the Experimental-Production Complex, B. Krasavin, chief metallurgist of the ZIL Association, and G. Petrov, chief of the Central Metallurgical Laboratory of ZIL: "A New Type of Cast Iron--Synthetic"]

[Text] Blast furnaces smelt two main types of products: conversion and foundry pig iron. The first of them is sent for refining to steel in converters and open hearth furnaces, while the second is used for production of ingots in cupolas at machine building plants. Strict requirements are placed on the latter, which conversion pig iron does not meet. At the same time blast furnace operators are very much interested in stopping the production of foundry pig iron and total conversion of furnaces to smelting conversion pig iron. This may bring many economic advantages--the productivity of blast furnaces is reduced by 25 percent every time a transition is made for smelting foundry pig iron and the coke consumption increases by 20 percent.

Specialists have already been involved for a decade in study of methods of using conversion pig iron in machine building. The conclusion in general terms reduces to the following: yes, replacement of foundry pig iron by conversion pig iron is essentially possible, but only if a number of technical measures are implemented.

The fact is that conversion pig iron is characterized by low silicon content. Therefore, a special silicon-containing additive—ferrosilicon—is used to produce quality castings from it. All the components in the cupola charge should be weighed carefully. And after melting, the metal must be sent to a special large-capacity furnace (mixer) for equalization of the chemical composition of the pig iron. In this case the mixer should be equipped with an electric heater.

As one can see, the use of conversion pig iron in machine building requires implementation of technical measures related to large capital expenditures.

They are needed to increase the capacity of plants which produce silicon-containing additives, for organization of production and equipping existing foundries with weighing devices and electric furnaces.

Nevertheless, the given variant is preferable. According to the evaluation of specialists, the saving from the use of conversion pig iron in casting production comprises approximately four million rubles with regard to all expenditures calculated per million tons of metal. However, the experience of plants that have converted to the use of conversion pig iron (and there are such enterprises) indicates that insignificant, but inevitable deviations of the production process during mass production lead to a sharp increase of rejected castings. Nevertheless, in the final analysis the saving is reduced to a minimum. How is this so?

Having carefully studied the existing situation, specialists of the Scientific Production Association Tulachermet and the ZIL Association proposed a method to kill two birds with one stone: that is, to provide the machine builders with high-quality cast iron with simultaneous smelting of only conversion pig iron at metallurgical plants. The process of saturating it with the necessary quantity of silicon outside the blast furnace was developed. We shall not touch on the research, experiments and tests here. We shall say only that it was possible to produce metal with high casting properties. By analogy with chemistry, the specialists called this cast iron synthetic.

Several methods of smelting it have now been developed and are already being used in the blast furnace of Tulachermet. The basis of them is smelting the conversion pig iron in the blast furnace, to which the silicon-containing additives, specifically ferrosilicon, are added upon release from the furnace to the spout. To reduce silicon losses, the additives are introduced at specific periods and are pulverized to the necessary dimensions prior to feeding.

Let us emphasize that synthetic cast iron has high quality such as that needed by foundry workers. It has been used for several years already at the Automotive Plant imeni Likhachev. Consumption of it has reached 80,000 tons annually. They have refused to use ordinary foundry pig iron at ZIL.

Some increase of ferrosilicon production is required to organize output of synthetic cast iron (as, incidentally, with other versions of converting machine building plants to conversion pig iron). It becomes possible in this case to free the blast furnaces from smelting foundry pig iron, their capacities are used much better and it is possible to save a large amount of scarce coke.

To stop smelting of foundry pig iron in blast furnaces and to convert them to production of synthetic pig iron, Minchermet [Ministry of Ferrous Metallurgy] of the USSR should be concerned about increasing ferrosilicon production at ferroalloy plants.
[56-6521]

6521
CSO: 1842

BRIEFS

METAL CASTING--Workers of the Mogilev branch of the Physicotechnical Institute of the Belorussian SSR Academy of Sciences have developed a new method of casting hollow parts from ferrous and nonferrous metals and alloys. The molten metal is fed into a crystallizer. The crystallizer is intensively cooled by water and the outer contour of the part to be smelted is rapidly formed to it. The liquid melt fills the crystallizer, which maintains the calculated hardening rate of the metal. The intensity of heat dissipation at different moments of shaping the casting can be easily varied. Thus, it is possible to produce parts with given structure and physicomechanical properties. The yield of suitable products reaches 95 percent and the strength of the parts is increased 1.5-2 times. The achievement of the Belorussian scientists makes it possible to mechanize and automate foundry work. [Text] [Minsk SOVETSKAYA BELORUSSIYA, 10 Oct 79 p 2] 6521

[54]

USSR UDC 621.039.532.21

EFFECT OF NEUTRON IRRADIATION ON GRAPHITE ALLOYED WITH SILICON AND BORON

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 9, Sep 79
pp 1684-185 manuscript received 31 Jan 78

VIRGEL'YEV, YU. S., NAKARCHENKO, YE. I., KUROLENKIN, YE. I. and PEKAL'N, T. K.

[Abstract] The effect of neutron irradiation on siliconized and boro-siliconized graphite was studied in relationship to the change in dimensions of the parts being tested. Low-temperature irradiation (70°C) of ordinary and siliconized graphite showed that the relative change of dimension was greater in the latter. Also, when there is 50-70 wt % silicon carbide in the siliconized graphite there is a higher radiation growth of the graphite. This was also true for irradiation at 200°C. When the content of boron carbide reaches almost 20% there is a noticeable tendency of samples to undergo radiation compression (shrinkage) and an extremum which is explained by the presence of two simultaneous processes. The first process involves the formation of large intermediate dislocation loops in the boronized graphite while the second process consists of the formation of a structural (vacancy) porosity filled with helium which comes from splitting the B^{10} isotope during irradiation. The helium promotes crushing of the hard matrix by the "swelling" it creates, which is greater the higher the boron content. Irradiation at 540 and 750°C also revealed the shrinkage effect in boronized graphite and increased strength when subjected to a flux of $2 \cdot 10^{20}$ neutron/cm^2. Figures 2; references 5: 3 Russian, 2 Western.
[49-6368]

USSR UDC 621.78:669.715

FEATURES OF THE HEAT TREATMENT OF AL9 AND AL34 ALUMINUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 10, 1979 pp 58-59

VASILEVSKIY, KH. G. and POSTNIKOV, N. S.

[Abstract] The possibility of increasing the pre-quench temperature, reducing the homogenizing time, and improving the precision of aging of cast AL9 and AL34 aluminum alloys (both containing $\leq$0.1% each of titanium, zirconium, and boron) was investigated. Two-stage pre-quench heating (1 hr at 535°C and 1 hr at 545°C) was found to maximize the strength of these alloys and reduce in half their homogenizing time. Two-stage aging (with the first-stage temperature, 195-200°C, being higher than the second-stage, 150-175°C) also enhances the strength of these alloys, and the high-temperature first-stage aging causes the dissolution of the Guinier-Preston zones forming in the course of prior natural aging, and thus prevents the decrease in strength. References 2 (Russian).
[23-1386]

USSR UDC 621.78:669.715

HEAT TREATMENT OF HIGH-STRENGTH PELLETIZED ALUMINUM ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 9, 1979 pp 43-44

FEDOROV, V. M., YELAGIN, V. I., SIZOVA, R. M. and SOKOLOV, A. S.

[Abstract] Stepwise heating of granular Al-Cu-Mg and Al-Zn-Mg alloys for fabrication of castings with subsequent quenching leads to an improvement in the strength properties, especially the yield limit, in comparison with single-stage heating. The strengthening of such alloys was explained by the separation of the alluminides of the refractory metals, formed during the breakdown of the supersaturated solid solutions of these metals in aluminum during heating and deformation. The starting material was comprised of 2.0 mm pellets having the composition: Mg, 3.5%; Zn, 10%; Cu, 2.0%; Cr, Zr, 0.6%; Be, 0.005%; Al, remainder. This material was briquetted and sintered into rods 12 mm in diameter. Heating for 1 hour at 400°C leads to a decrease in the number of soluble phases and to further breakdown in the solid solution of the refractory metals, which significantly increases the crystal lattice parameter of the solid solution. Increasing

the time to 10 hours at 400°C does not change the number of dispersed secondary phases of the refractory metals. Increasing the heating time at 400°C to 20 hours leads to a coagulation of the secondary "intermetallides" of the refractory metals and, as a consequence, to the subsequent reduction in the strength properties and plasticity. After the complete heat treatment in the two-stage procedure, the strength was 37 kg/mm^2 as compared with 31 kg/mm^2 for the single-stage process.
References 3 (Russian)
[26-12027]

USSR UDC 621.762.4.045:621.763.4.045

ISENTROPIC COMPACTION OF FIBROUS AND COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 30-34 manuscript received 30 Mar 78

MANUKYAN, N. V. and MINASYAN, V. Ts., Yerevan Polytechnical Institute

[Abstract] Copper fibers 0.05, 0.08, 0.10 and 0.13 mm in diameter were compressed and then annealed in a hydrogen medium at 750°C. Then the effects of compaction were analyzed. The diameter of fibers was found to be of importance only at slow rates of speed; when other conditions were equal small-diameter fibers were found to be preferable. Composite materials based on PZh2M iron powder were similarly treated and analyzed, at rates of 40-140 m/sec. These samples were reinforced with steel fibers. Calculations indicated that isentropic compaction is related to the compression wave and the kinetic energy of the shell. Wave compaction of the copper fibers at a speed of 80 m/sec was 5-8 percent; the remaining compaction was attributed to the kinetic energy of the shell. Figures 4; references 5: 4 Russian, 1 English.
[43-12131]

USSR UDC 621.792.5:669.0.18.45-138.8

COMPACTING OF POROUS ZIRCONIUM DIBORIDE AND TITANIUM DIBORIDE POWDER BRIQUETS DURING SINTERING

Yerevan PROMYSHLENNOST' ARMENII in Russian No 9, Sep 79 pp 36-39

PANKEVICH, A. P., Candidate of Technical Sciences, GASPARYAN, L. A., engineer

[Abstract] Activated sintering of refractory powder materials eliminates the need for hot pressing and generally improves the manufacturing technology of powdered material products. A study was made of the compacting phase of the process involving ZrB_2 and TiB_2 powders prepared by either the carbothermal method (at the All-Union Scientific Research Institute

of Refractory Metals and Hard Alloys and at the Donetsk Plant of Chemical Reactants) or the borocarbide method (at the Institute of Problems of Material Sciences, Academy of Sciences Ukrainian SSR). Specimens of these powders were ground, mixed, soaked in a benzene solution of rubber, cold pressed under 1 ton/cm^2 and vacuum sintered at a heating rate of 30-40°C/hour. The results of kinetic measurements indicate that almost nonporous (98-99% density) briquets can be produced at relatively low sintering temperatures (1600-1750°C) in a short time (15-30 min), if the initial powder contains adequate amounts of iron and chromium, lowering the shear viscosity and thus facilitating the mass transfer process. The presence of gaseous iron and chromium vapor during sintering, as revealed by mass-spectrometry and x-ray structural analysis, does not seem to adversely affect the shrinkage. Figures 1; references 4 (Russian).

USSR UDC 536.46.546.832

AN INVESTIGATION OF THE REACTIVE PROPERTIES OF VARIOUS FORMS OF CARBON DURING SYNTHESIS OF TITANIUM CARBIDE BY THE SHS METHOD

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 6-10 manuscript received 29 Dec 78

SHKIRO, V. M., BOROVINSKAYA, I. P. and MERZHANKOV, A. G., Department of the Institute of Chemical Physics, Academy of Sciences USSR

[Abstract] Cylindrical pressed mixtures of stoichiometric carbon and titanium, with several types of carbon were used, and compression was done in an argon medium. Results showed that with increased structure of the carbon the speed of combustion and completeness of transformation declined. Heat treatment of the PM-15 carbon soot at 2100°C in a vacuum brought increased density but no change in dispersion. The specific surface value of the carbons used had no effect on their reactive properties; rather, structural, energy and chemical factors were involved. Figures 2; references 21: 18 Russian, 1 Czech, 2 English. [43-12131]

USSR UDC 621.762

AN INVESTIGATION OF THE SURFACE OF A HIGH-DISPERSION TITANIUM NITRIDE BY THE METHOD OF X-RAY PHOTOELECTRONIC SPECTROSCOPY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 1-5 manuscript received 26 May 78

SHUL'GA, YU. M. and TROITSKIY, V. N., Department of the Institute of Chemical Physics, Academy of Sciences USSR and the Institute of New Chemical Problems, Academy of Sciences USSR

[Abstract] Titanium nitride obtained by oxygen reduction of $TiCl_4$ in a nitrogen plasma stream was annealed in a quartz ampule in a regulated oven at 10^{-5} mm Hg. After cooling, X-ray photoelectronic spectra were recorded. Titanium dioxide was also produced and analyzed. The results indicated that the oxidized surface had a higher energy bond and the oxynitride surface film had an average thickness of about 10 Å. High temperature annealing was ineffective in eliminating that film. Figures 2; references 10: 4 Russian, 6 Western.
[43-12131]

USSR UDC 621.762

REINFORCEMENT OF NICKEL WITH CARBIDE-COATED CARBON FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 43-46 manuscript received 20 Dec 78

OVCHARENKO, V. YE., KASHIN, O. A., DUDAREV, YE. F., LAPSKER, I. A. and TUROVETS, L. A., Siberian Physico-Technical Institute

[Abstract] Plaits of 300 filaments of the VMN-4 type were coated with carbide in a bath at 1150°C at 10^{-4} mm Hg. Then X-ray structural and spectral analysis was used to evaluate the coating and determine its suitability for strengthening a nickel matrix. Results showed the formation of micropores at the plait boundaries which increased in number and size with increases in the annealing period and its temperature. Successful application of the method reqires preliminary prevention of the carbide's tendency to dissolve in the nickel matrix. Figures 4; references 11: 10 Russian, 1 English.
[43-12131]

USSR UDC 669.018.25:620.187.5

THE INTERRELATION OF STRUCTURE AND PROPERTIES OF HARD ALLOYS WITH TITANIUM CARBIDE BASES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 73-79 manuscript received 15 Jan 79

PILYANKEVICH, A. N., SHAPOVAL, T. A., DZODZIYEV, G. T. and PADERNO, V. N., Institute of Problems of Material Science, Academy of Sciences Ukrainian SSR

[Abstract] An electron microscope was used in a two-stage replication method. Samples were first shaded with chrome for studying fractures, then with platinum for studying the microstructure. Samples were polished prior to microscopic examination. Samples with low durability during bending, such as the TN-20 alloy, had ex emely unequal granular structures and underwent a directional orientation of large and small grains. More durable solid solutions contained titanium carbide grains of less than 2 mkm average width with serrated or angular forms. The prime tasks in improving quality relate to perfecting the technology for preparing the initial compounds, improving sintering processes, and increasing material purity. Temperature factors had varying roles in failure of titanium carbide-nickel-molybdenum products. Figures 5; tables 1; references 9: 6 Russian, 3 English.
[43-12131]

USSR UDC 621.762

MODERN METHODS OF PRODUCING METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 79 pp 1-10 manuscript received 5 Apr 79

NICHIPORENKO, O. S., Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] A ten-year survey of the Soviet Union's powder metallurgy industry is made. Some of the highlights of this decade include the first industrial production of iron powders in 1978 by spraying at the Brovarsk Powder Metallurgy Plant (BPMP) where they started up a shop for this purpose with a capacity of 17,000 ton/year. The basis of this technology is spraying synthetic cast iron with compressed air with subsequent annealing of the raw powder in converter gas. This method was developed jointly by BPMP, the Institute of Problems of Materials Science (IPMS) and the Central Scientific Research Institute of Ferrous Metallurgy (TsNIIChermet). The technology of producing iron powders by spraying with

water was developed by Tulachermet, IPMS and TsNIIChermet while the technology of producing iron and their alloys with controlled particle shape was done at IPMS. Reduction of metal oxides is done at various plants by different methods. At the BPMP a horizontal-through furnace is used; at the Sulin Metallurgical Plant (SMP) tunnel furnaces are employed; the Dneprov Aluminum Plant (DAP) uses stack furnaces. The Donets Scientific Research Institute of Ferrous Metallurgy (DonNIIChermet) has developed a flocculation method where ground iron powders are fed into a pulsing magnetic field where they are magnetically oriented, which stimulates formation of the so-called "floccules" that are porous but strong conglomerates when treated further with hydrogen. The development of nuclear power engineering has presented the possibility of forming a nuclear-metallurgical complex for producing pure and cheap hydrogen from the heat of nuclear reactors with subsequent reduction of high purity superconcentrates by the hydrogen. TsNIIChermet and Tulachermet have developed and mastered the metallothermal reduction of iron and alloy steel powders of calcium hydride. Scientists at IPMS have developed and introduced diffusion saturation from point sources in the production of alloyed steels and alloys. The number of new methods of producing powders include combination methods with a scheme of production of raw material-powder-part (spraying with subsequent stamping or rolling of the hot powder, self-propagating high-temperature synthesis (SHS) and methods of rotating electrode spraying and vibrating electrode spraying. The Institute of Physical Chemistry has developed a method of producing inorganic powders based on conducting an exothermal reaction of the components in the SHS mode. References 23: 17 Russian, 6 Western.
[24-6368]

USSR UDC 621.762

MODERN MATERIALS BASED ON REFRACTORY COMPOUNDS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 79 pp 11-24 manuscript received 1 Feb 79

KOSOLAPOVA, T. YA., Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] The methods employed to produce refractory compound powders are discussed. Plasmochemical synthesis of refractory powders which can be done at 5000-10000°K, was used to synthesize aluminum nitride and can be applied to the synthesis of other refractory compounds. The Institute of Problems of Material Science and the Institute of Metallurgy jointly investigated the production of single crystals of Ti, Zr and Nb carbides by melting sintered cores from the corresponding carbides. At the Physico-technical Institute imeni A. F. Ioffe production of refractory compound single crystals was studied, where the initial materials are crystallized from solutions into metallic melts. Figures 6; references 29: 28 Russian, 1 Western.
[24-6368]

USSR UDC 621.762

INTERACTION OF YTTRIUM OXIDE WITH CHROMIUM IN THE THIN-FILM STATE IN THE PRESENCE OF OXYGEN

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 79 pp 96-100 manuscript received 1 Jun 78

KARPINOS, D. M., LISTOVNICHAYA, S. P., BALAKHNINA, V. N. and OKUNEVSKIY, YU. N., Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] Luminous and electron microscopy and x-ray phase analysis were used to study the interaction between yttrium oxide and chromium thin films. A three-layer sandwich (yttrium oxide-chromium-yttrium oxide) was applied to a polished policor plate with the thickness of each being about 0.3 microns. When the plate was annealed the sandwich was exfoliated cleanly but, if the film thickness was increased from 0.3 to 1.5 microns, it cracked. Isothermal annealing at 600-1500°C showed that at 900-1000°C the grains in the yttrium oxide film increased to one micron and at 1000-1500°C--up to 3--4 microns. Also a new phase formed which was situated along the yttrium oxide grain boundaries. At temperatures above 1000°C a network of microcracks with a mosaic structure formed on the film surface in all cases. It was concluded that the interaction of the thin-film yttrium oxide-chromium system starts at around 1100°C and is fully complete at 1400°C with the formation of yttrium chromite. The interaction occurs primarily along the microcrack network with a gradual filling of individual cells with the new phase. Apparently, the microcrack lattice plays the role of primary diffusion paths along which the oxygen, necessary for forming yttrium chromite, is transmitted to the yttrium oxide-chromium interphase boundary. Figures 3; references 5: 1 Russian, 4 Western. [24-6368]

USSR UDC 621.762:621.763:541.13:624/628

DEVELOPMENT OF WORKS IN THE FIELD OF HIGHLY POROUS MATERIALS MADE OF METALLIC POWDERS AND FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 79 pp 25-35 manuscript received 2 Apr 79

FEDORCHENKO, I. M., Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] A survey is made of studies devoted to the development of metallic highly porous materials. The existing methods of powder metallurgy employed in producing porous parts such as filters are discussed as well as porous materials made from metallic fibers. Porous materials for electrochemical and electrophysical application and structural penomaterials are briefly discussed and the article concludes with descriptions of the areas of porous material application such as the use of stainless steel filters in nuclear and cryogenic engineering, pharmocology, chemistry, in the production of polymers and synthetic fibers and in separators of liquid and gas media. References 44: 22 Russian, 22 Western.
[24-6368]

REFRACTORY COMPOUND SYNTHESIS DISCUSSED

Moscow IZVESTIYA in Russian 4 Nov 79 p 1

[Article by V. Popovkin: "The Effect of a Fire Wave"]

[Text] This white-hot fire wave, ignited by the hand of man and burning on its own, hidden internal energy, is truly capable of creating miracles. Seemingly unjoinable refractory materials are joined into a solid piece in its flame.

The method, which permits this to be accomplished, has been named the SVS [Self-propagating high-temperature synthesis] method, synthesis of refractory compounds, by scientists of the Institute of Chemical Physics of the USSR Academy of Sciences. Approximately 200 of the most diverse compounds--carbides, borides, silicides, intermetallides and nitrides--have already been produced by using it. Each of them finds practical application in the national economy. An important property unites all these materials: produced by means of so-called "gasless combustion," they have high purity.

"To excite or 'ignite' this self-propagating materials synthesis wave," says Professor, Doctor of Physicomathematical Sciences A. Merzhanov (head of the Department of Macroscopic Kinetics of Chemical Reactions), "a short thermal pulse with temperature on the order of 1,000-1,500 degrees Celsius is sufficient. Synthesis is then developed spontaneously, being propagated in the form of a wave along the entire volume of the material with release of an enormous amount of heat. In this case the temperature rises to 2,000-4,000 degrees."

High-temperature furnaces and high pressure of an inert medium are not needed here and large expenditures of electric power are not required--the synthesis reaction supplies energy by itself. Production of both the synthesized materials themselves and of metallurgical molds of them is practically without waste.

The saving from this work, achieved during the past two years by scientists of the Institute of Chemical Physics in cooperation with producers of the Poltava Synthetic Diamond and Diamond Tool Plant and colleagues from the Institute of Problems of Materials Science of the Ukrainian SSR Academy of Sciences, is 39 million rubles. Investigators are transferring this work, which underwent extensive experimental-industrial debugging, for total industrial introduction at the VPO [All-Union Production Association Soyuzabraziv of Minstankoprom [Ministry of the Machine Tool and Tool Building Industry]].
[54-6521]

6521
CSO: 1842

CARBONITRIDE STRENGTHENING OF STEEL

Moscow STROITEL'NAYA GAZETA in Russian 11 Nov 79 p 3

[Text of interview with USSR State Prize winners V. Kuznetsov and L. Gladshteyn, both of the Central Scientific Research Institute for the Design of Steel Structures, by Correspondent A. Gorbatov: "Testing for Strength"]

[Text] A team of scientists, engineers, and designers was awarded the title of 1979 USSR State Prize Winners for the development and introduction of highly effective carbonitride-hardened steels. Our correspondent A. Gorbatov asked the prize winners--Chief Engineer of the Central Scientific Research Institute for the Design of Steel Structures V. Kuznetsov, and department head at that Institute L. Gladshteyn--to comment on the significance of this development.

"Inventors sometimes find it difficult to assess the role of their brainchild, but this is a special case. The point is that the development and introduction of a new steel is such a far-reaching project requiring extensive effort by specialists from various branches of the economy that we can state with absolute confidence that our large team of inventors has accomplished a major feat.

"The specialists at our Institute had chiefly to solve the problems of the practical application of the new steel type in construction. As for the development itself of that steel, it was handled by numerous crews of metallurgists, and primarily by the scientists and engineers of the Urals.

"Metal is now a customary basic building material. There is no limit to the use of steel in construction--vehicular and railroad bridges, frameworks of large industrial buildings, huge reservoirs, and even bread bins. The demand for steel is always rising. But the resources of metals are not limitless. And in our opinion the demand for metal can be solved down in one way--by enhancing its strength.

"Attempts to enhance the strength of structural steel have long been in the making. Its carbon content was increased, and it was treated with special additives. That is, alloyed.

"But until recently structural steels with a yield point of more than 50 kg per square millimeter did not exist. The problem was that welding is widely employed to join metal structures. And increasing the content of carbon and alloy elements in steel is detrimental to its weldability.

"Still this problem was finally solved in our country by developing economically effective high-strength and cold-resistant steels for structural weldments in mass use. A fundamentally new method for modifying the structure and properties of metal, termed the carbonitride hardening method, has been developed.

"This hardening method is based on using vanadium as the principal alloy element. It is added in the amount of from 5 to 15 hundredths of a percent to steel. It has now become possible to widely apply carbonitride hardening in order to obtain the most broadly used steels, since vanadium output in our country has in recent years been increasing.

"The industrial production of rolled stock from the new structural steels has been organized at the Orsk-Khalilovka and Nizhnetagil' metallurgical combines and at the Novolipetsk and Cherepovets metallurgical plants. These high-strength steels are used to fabricate effective welded components of the frames of large industrial buildings, bridges, trestle structures, reservoirs, gasholders, blast furnaces, and large load capacity cranes.

"But that is not all.

"As soon by numerous studies, the method is universal and can be used to enhance the quality of steels of varying purpose.

"On the basis of the principles of carbonitride hardening a unified group of low-alloy structural steels with coordinated strength levels has been developed for the first time in Soviet practice. This has provided designers and planners with a selection of effective materials for use not only under standard climatic conditions but also at temperatures below -40°C."
[47-1386]

1386
CSO: 1842

USSR UDC 66.14.18.258.2

DEVELOPMENT OF 30Kh3NM3FTs HIGH STRENGTH HEAT RESISTANT STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 10, 1979 pp 51-55

ZAKHAROV, V. N., PERTSOVSKAYA, YE. V., SKLYUYEV, P. V. and ZONOV, V. V., Uralmash Production Association

[Abstract] The new low-tungsten 30Kh3NM3FTs steel (% content: 0.28 C, 0.32 Si, 0.23 Mn, 2.5 Cr, 1.35 N, 2.5 Mo, 0.40 V, 0.012 S, 0.012 P, 0.06 Zr) was developed as a substitute for the scarce 3Kh2V8F tunsten steel. It is superior to other previously tried substitutes, because it is additionally treated with 1.0-1.5% Ni and 0.04-0.1% Zr. Treatment with Ni makes this steel amenable to air quenching, while the addition of Zr enhances the stability of supercooled austenite, with Zr acting as a modifying agent assuring a spheroidal shape of sulfides as well as of the phases segregating along the grain boundaries, and thus resulting in an increase in the plasticity and impact strength of the metal, which is equivalent to reducing the sulfur content of the steel from 0.025% to 0.010%. This new steel can be used in lieu of 3Kh2V8F steel as the material of pressforging components measuring up to 200 mm in cross section and performing under static loading. The short-time strength of 30Kh3NM3FTs steel at normal and high temperatures as well as its hot hardness and stress-rupture strength and other properties are close to those of 3Kh2V8F steel, while its plasticity and impact strength are even higher. Figures 5; references 5: 4 Russian, 1 Western.
[23-1386]

USSR UDC 621.78.061

EFFECT OF OXIDATION IN VARIOUS MEDIA ON IN VACUO GAS RELEASE BY 12Kh18N10T STEEL

Moscow IVUZ. MASHINOSTROYENIYE in Russian No 10, 1979 pp 110-114 manuscript received 16 Feb 78

MAKAROVA, V. I., SAFONOV, A. N., SKIBINA, G. V. and YEROKHINA, V. I.

[Abstract] At present 12Kh18N10T corrosion-resistant austenitic class steel is used as the principal structural material in vacuum systems. But the conventional techniques of reducing its gas release rate in vacuo are excessively complicated. In this connection, it is shown that heating that steel at 600°C for 2-3 hr in an atmosphere with a low partial pressure of oxygen (in vacuo or alternately in vacuo and in hydrogen) reduces

to a minimum the formation of the oxide Fe_2O_3 and promotes the formation of surface oxide films (spinel FeO x $(Fe, Cr)_2O_3$) and rhombohedral $(Fe, Cr)_2O_3$) which, owing to their high chromium content, provide a barrier to the release of the hydrogen and carbon dissolved in the bulk of the metal. Such treatment reduces to one-sixteenth the overall gas release rate of the steel compared with its passivated counterpart. The high performance characteristics of the resulting steel surface (low gas release following prolonged exposure to the atmosphere as well as subsequent cleaning of the surface) serve to simplify the production technology of vacuum systems. Figures 3; references 3 (Russian).
[18-1386]

USSR UDC 621.186.4:669.15'24'25'28'27'295-192

ON THE MECHANISM OF SLOW FAILURE OF TYPE N17K10V10MT HIGH-STRENGTH MARTENSITE-AGED STEEL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 9, 1979 pp 38-41

KARDONSKIY, V. M., MALKIN, V. I., GORBUNOVA, N. B., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Samples of N17K10V10MT steel were aged at different temperatures and deformed at a rate $\xi = 10^{-3}$ and 10^{-5} sec $^{-1}$. A plot of the parameters of relative thinning and limits of strength show that after aging at 400-500°C, the plasticity of the steel at small deformation rates is sharply reduced. Minimal necking is observed after aging at 420 - 450°C. Photomicrographs show that a fracture in steel aged at 420°C has a pitting pattern similar to unaged steel. As the aging temperature is increased, both the plasticity and the strength of the steel increase. In order to observe the embrittlement of the steel, it must be subjected to loading for longer periods of time. Hydrogen embrittlement is particularly noticeable in samples aged at temperatures of 420 - 450°C and is accompanied by the breakdown of the solid solution. The reaction of the hydrogen with dislocations in the material structure does not significantly influence the embrittlement process. The temperature after which embrittlement occurs increases with increasing duration of aging. Figures 3; references 2: 1 Russian, 1 Western.
[26-12027]

USSR UDC 621.762

THE EFFECT OF STRUCTURAL FACTORS ON MECHANICAL PROPERTIES OF SUPERHARD MATERIALS BASED ON BORON NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, 1979 pp 61-69 manuscript received 6 Apr 79

BOCHKO, A. V., GRIGOR'YEV, O. N., DZHAMAROV, S. S., KARYUK, G. G., KURDYUMOV, A. V., OLEYNIK, G. S., PILYANKEVICH, A. N., TREFILOV, V. I., FRANTSEVICH, I. N. and SHATOKHIN, A. M., Institute of Problems of Material Sciences Ukrainian SSR

[Abstract] Analyses by optical and electronic microscopy, X-rays, micropressure tests, radial fracture length, and load hardness were made on hexanite-R, "elbor," PTNB-3MKT, PTNB-IK-1, "belbor," "ismit-2" and "ismit-3," and a composite. All of these Soviet products were tested using production samples except hexanite-R. Analysis showed that for the smaller grain textured compounds hexanite-R, ismit-1 and ismit-3, intercrystalline failure was typical, while with increasing granular dimensions trans-crystalline failure grew. In polydispersion materials mixed forms were found. The effects of sphalerite, wurzite and graphite-type phases were not related to hardness. Two-phase hexanite-R had the greatest dispersion, homogeneity of grains, and consistency. The other materials were more subject to brittle fracture, low dispersion, and the presence of impurities and irregular phase content. Figures 5; tables 3; references 17: 12 Russian, 4 English, 1 German.
[43-12131]

USSR UDC 669.295.'71'292'28:539.4.015

A STUDY OF THE STRENGTHENING OF HIGH TEMPERED TITANIUM ALLOYS IN THERMO-MECHANICAL TREATMENT

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48 No 1, Jul 79 pp 141-147 manuscript received 22 May 78

ANISIMOVA, L. I., MAKHNEV, YE. S. AND POPOV, A. A., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] Industrial VT22 high-tempered titanium alloy, containing 5.5% Al, 4.5% V, 4.5% Mo, 1.3% Cr and 1.1% Fe, was tested at temperatures ranging from 820 to 1000°C with subsequent water cooling, and with varying degrees of deformation, ranging from 0 to 50%. Specific effects of the two parameters on the alloy are discussed. Results indicated that granular creep occurs in the temperature range up to 40% compression, thus preventing strengthening of the alloy. Aging tests in the range of 625-650°C with deformation in the alpha-beta zone brought intensive coagulation of alpha-phase particles. The optimum results in mechanical properties came with deformation in the two-phase zone and subsequent aging at 630-640°C for 2-4 hours. Figures 4; references 3 (Russian).
[31-12131]

USSR UDC 541.44:539.238

SOME FEATURES OF THE SYNTHESIS OF THIN FILMS OF TRANSITION METAL HYDRIDES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 9, Sep 79
pp 1579-1584 manuscript received 5 Jul 78

KHODYREV, YU. P., BARANOVA, R. V., IMAMOV, R. M. and SEMILETOV, S. A., Institute of Crystallography imeni A. V. Shubnikov, Academy of Sciences USSR

[Abstract] The methods of producing thin films of transition metal hydrides for electronographic structural analysis and phase-formation relationships were examined. Experiments were conducted to synthesize hydride thin films by interaction of metallic films (Pd, Ni, Au, Cr, Sc) with molecular and atomic hydrogen and with H+ ions, by cathodic spraying in an H_2 atmosphere (Ni, Pd, Sc, Co, Cr, Cu and Ag), by electrochemical deposition (for Cr hydrides), electrochemical saturation (Ni and Pd) and by combustion of metals (Ni, Pd, Co, Ti, V, Ag and Au) in hydrogen. From structural and interstitial phase analysis the lattic type and parameters were identified for the metals used to form the hydride. Since nitrogen impurities were present in the hydrogen and residual gases of the electronograph, ammonia was formed which in turn created nitrides in the hydride films. References 23: 10 Russian, 13 Western.
[49-6368]

USSR UDC 546.821+546.18

INVESTIGATION OF THE KINETICS AND MECHANISM OF INTERACTION OF TITANIUM WITH PHOSPHORUS VAPORS AT 800°C

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 10, Oct 79 pp 1868-1869 manuscript received 11 Apr 78

UGAY, YA. A., ILLARIONOV, A. A. and GUKOV, O. YA., Voronezh State University

[Abstract] When rectangular plates of VT-1-0 grade titanium are annealed at 800°C in the presence of phosphorus vapors the weight of the samples is increased by the formation of Ti phosphides. When the process is conducted at pressures below 2.5 atm the growth of the phosphide layer consists only of TiP and its growth follows the quadratic law. At pressures of 5-10 atm growth of the phosphide layer changes to logarithmic and consists of the TiP layer and a thinner TiP_2 layer. These films provide excellent protection of the titanium from corrosion by hydrochloric and sulfuric acids. The phosphide films provide corrosion protection by retarding diffusion of those elements which can react with titanium to produce corrosion. Figures 2; references 5: 4 Russian, 1 Western. [48-6368]

USSR UDC 669-176:669.295

THE INFLUENCE OF TEXTURE ON THE MEMORY EFFECT OF TITANIUM NICKELIDE FORMS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 9, 1979 pp 62-63

MONASEVICH, L. A., PASKAL', YU. N., PRIB, V. E., TIMONIN, G. D., and CHERNOV, D. B.

[Abstract] A study of the memory effect of titanium nickelide was made using a 50 atomic wt % Ni alloy of Ti. The texture, determined by using a difractometer, could be described on the basis of the ideal orientation (112) [110]. The greatest deformation accumulated in samples intersected at angles of 0,22.5, and 45° to the "direction of rolling" during the preparation of the samples. Somewhat less deformation accumulated in those samples intersected at an angle of 90° to the "direction of rolling" and significantly less in those samples intersected at 67.5°. This relationship held when the rotation stress was increased to 30 kg/mm^2; however, the differences among the various angles decreased with increasing loading. A relationship was also observed between the temperature of initiation of the martensite transformation under loading M_i,

and the orientation of the axis of the sample relative to the "direction of rolling", (30 - 50°). The greater the accumulated deformation, the higher the M_i. The temperatures of initiation (A) and completion (B) of the reverse martensite transformation under loading vary within the range of 10 - 15°C: the greater the accumulated deformation, the lower are A and B. Figures 2; references 6: 2 Russian, 4 Western.
[26-12027]

USSR UDC 669.295

AN INVESTIGATION OF THE POSSIBILITY OF PHOTOMETRIC SORTING OF SPONGE TITANIUM ON THE "SORTEKS-621" SEPARATOR

Ordzhonikidze IVUZ. TSVETNAYA METALLURGIYA in Russian No 5, 1979 pp 88-91
manuscript received 30 May 78

TSYPIN, YE. F., LIKHTERMAN, V. A., SHIRYAYEV, R. YE. and CHERNITSKIY, L. P., Leningrad Mining Institute, Department of the Metallurgy of Light and Rare Metals

[Abstract] Sorting of sponge titanium for specific defects by adjusting the separator for the individual defect, general defect sorting with a single setting, and two-phase sorting using the "Sorteks-621" were investigated. It was found that defective pieces of all types could be rejected except those with residual powder metallurgy flaws. The best results were obtained when the separator was adjusted for a particular flaw. The greatest success was in eliminating defects related to oxidation and burning. Improved surfaces, light filters, and sensitivity adjustments would bring better results. References 2 (Russian).
[41-12131]

USSR UDC 669.017

THE EFFECT OF INITIAL STRUCTURE ON DEFORMATION RESISTANCE AND THE QUALITY OF STAMPINGS OF VT9 ALLOY DURING ISOTHERMIC DEFORMATION

Ordzhonikidze IVUZ. TSVETNAYA METALLURGIYA in Russian No 5, 1979 pp 71-74 manuscript received 10 Jul 78

BRAILOVSKAYA, B. F., YELAGINA, L. A., PILIPENKO, A. L., KAS'YANOV, S. A., and FREYMAN, L. B., All-Union Institute of Light Alloys

[Abstract] The effect of initial structure was evaluated under isothermic precipitation conditions and then tested under actual isothermic stamping conditions, using a fine globular and fibrous structure and a coarse granular structure of the alloy, at varying rates of deformation and at a temperature of 950°C in the alpha and beta phase areas. In the fine structure, granules increased in size during the process from 3 to 6 mkm, while maintaining axial form and increasing the degree of recrystallization. Little change occurred in the coarse structure at 30% deformation. Easier stamping and better stability after stamping was found in the fine-structured version of the alloy. The process surpassed the norms required for production. Figures 2; references 2 (Russian).
[41-12131]

USSR UDC 669.295:293:539.63

PHASE TRANSFORMATION IN TITANIUM-NIOBIUM ALLOYS UNDER THE EFFECTS OF SHOCK WAVES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48 No 1, Jul 79 pp 211-213 manuscript received 1 Aug 78

SIKOROV, V. N. and DEGTYAREVA, V. F.

[Abstract] Alloys containing 10, 20 and 30% Nb were annealed at 500°C for 5 hours in a vacuum of approximately 5 10^{-5} mm Hg, then subjected to shock waves from an explosion. Results indicated than an omega phase formed only when alpha-phase content was present in the original alloy. Thermal stability and phase content under pressure for the omega phase were measured. Omega-phase content was shown to decrease with increased temperature, and to be less after shock loading than under a static load. References 10: 7 Russian, 3 Western.
[31-12131]

BRIEFS

VACUUM WELDING--Simple contact of an aluminum wire to a single crystal of germanium forms a weld so strong within a fraction of a second that a break occurs in a different place during subsequent tests. These experiments are being carried out at one of the laboratories of the Institute of Physics of the Latvian SSR Academy of Sciences under superhigh vacuum conditions close to space conditions in their degree of evacuation. Ideal purity of materials in the contact zone is maintained here, as a result of which the atoms enter into direct interaction and are coupled to each other. Scientists feel that the first results of the "contact welding" method are of practical interest to modern electronics. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 7 Aug 79 p 1] 6521
[54]

USSR UDC 621.791.016:669.295

DIFFUSION WELDING OF INDUSTRIAL TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, 1979 pp 47-51 manuscript originally received 13 Mar 78, in final form 25 Jul 78

NAZIMOV, O. P. and GORSHKOV, YU. V., Candidates of Technical Sciences, and BELYKH, N. G. and IL'IN, A. A., Engineers, Moscow

[Abstract] OT4, OT4-1, VT20, VT6, VT16 and VT15 industrial alloys were welded in various combinations directly and with intermediate layers. Welding was done in a laboratory vacuum furnace, after preliminary cleaning with acetone and alcohol, and at varying pressures. Results showed that satisfactory seams were obtained with the use of alloys with similar atomic weights with stable configuration or alloys with atomic weights with stable configuration that promote electronic adhesion. Where an intermediate layer was used, satisfactory bonds were obtained but the nature of the seams differed markedly from the alloys joined. Figures 4; references 9 (Russian).
[32-12131]

METALLURGICAL PRODUCTION DOWN IN VARIOUS SOVIET PLANTS

Moscow PRAVDA in Russian 13 Nov 79 p 2

[Unsigned article: "In Spite of Tradition"]

[Text] The country's metallurgists failed to meet production goals set for the first nine months of this year. Even less steel and rolled iron were produced during this period than in the first nine months of last year.

In a number of cases the shortfall has now reached alarming proportions. Production at the Kuznets Metallurgical Combine decreased by almost ten percent compared to the same period last year. The Nizhne-Tagil and Karaganda Combines, the Zapsib [West-Siberian Metallurgical Plant imeni 50th Anniversary of October] and enterprises of the Ukrainian SSR Ministry of Ferrous Metallurgy, as well as the Cherepovets, Novosibirsk, Gor'kiy and Chelyabinsk Metallurgical Plants all operated below capacity.

Tasked by the editorial office, "PRAVDA" correspondents visited some metallurgical plants and spoke with their managers, specialists and laborers. What are the reasons for the lapses that have been allowed? What measures are being taken to correct the situation that has developed? What reserves are being activated? How are socialist competition and advanced methods being used to these ends?

V. Gorbachev, chief of the Industrial-Transportation Section of the Dneprodzerzhinsk City Party Committee, has had a stack of telegrams on his desk since early morning. Each one of them appeals to him to send something, assist someone or exert his influence on someone. Who is the subject of all these appeals? The management of the Metallurgical Plant imeni Dzerzhinskiy.

"Over a period of ten months we have been in arrears in our obligation to a number of customers for a large quantity of rolled iron," plant director G. Gurskiy told V. Cherkasov, "PRAVDA" correspondent for the Dnepropetrovskaya Oblast. "And this debt is, alas, still growing. Over the last 27 years 401 million rubles have been invested in development of primary production while a total of 2.9 million was spent on maintenance services. This is 0.72 percent of the total allocation while the standard is six percent. And so frequent breakdowns, accidents and low-quality products have resulted."

On the initiative of the Baglayskiy by-product coke plant an open competition began three years ago among cooperating plants -- all those involved in turning out the final product -- rolled iron. A marked improvement was made in fulfillment of customer orders and day-to-day mutual assistance between the collectives grew stronger. But party and trade union committees did not concern themselves with development of this competition and it gradually ground to a halt.

"PRAVDA" associate correspondent I. Sergeyeva reports from Zaporozh'ye that the "Dneprostal'" plant is in arrears to the country for almost three million rubles worth of products. This is an unexpected showing for a collective that brilliantly fulfilled the past two five-year plans. One of the reasons for the shortfall here is poor organization of maintenance work. Outages of the electric furnace have become more frequent.

By the way, no lack of maintenance organizations is perceived. But their collectives show little interest in final results -- the stable operation of the metallurgical enterprises. But then the maintenance units in the non-ferrous metallurgical plants here in Zaporozh'ye do answer for their work. A competition for guarantee certificates of quality has been organized.

"Zaprozhstal'" is in arrears for 74,000 tons of steel and 49,000 tons of rolled iron. Of the problems the collective has encountered in recent years, those most frequently cited are difficulties with supply of coke, scrap metal and ore-concentrate ingots and shortages of personnel. Labor turnover has reached 20 percent and the plant is short hundreds of laborers. On-the-job training is poorly developed here and young people are slow to master essential professional skills.

In due course a competition was developed in Donbass metallurgical enterprises under the slogan "Interests of Cooperating Enterprises Above All!" Its essence was that collectives bound together by a single technological chain should help each other and strive to satisfy each other's needs.

The effectiveness of this competition has now markedly declined. "PRAVDA" correspondent for the Donetskaya and Voroshilovgradskaya Oblasts, I. Tikhomirov, reports that because of the low quality of ore-concentrate ingots arriving from the Central Ore-enrichment Combine blast furnace operators at the Kommunarsk Plant are in arrears for tens of thousands of tons of cast iron. Work results of the steel smelters and rolling mill operators are no less disquieting. The Yenakiyevo and Makeyevka Metallurgical Plants are in arrears for huge amounts. And the main reason here is a lack of intercommunication and elementary mutual understanding between the cooperating collectives. At Yenakiyevo, the example, the oxygen converter shop constantly lets the rolling mill operators down. Labor and technological discipline in this shop is low.

V. Shalgunov, "PRAVDA" correspondent for the Orenburgskaya Oblast, reports that according to a statistical account published by the local press the Orsk-Khalilovo Metallurgical Combine met its goals by 100.4 percent. But the enterprise is receiving alarming letters and telegrams from customers and is paying them large fines for non-delivery of products. What is the matter here? The fact of the matter is that the enterprise meets its quotas but at an uneven pace, falling thousands of tons behind in its obligations to provide steel to customers. Responsibility for this rests, to a significant degree, with the cooperating enterprises. Orsk-Khalilovo blast furnace operators have failed to receive hundreds of thousands of ore-concentrate ingots from the Lebedinskiy Combine since the first of the year. The Bekabad Metallurgical Combine in the Uzbek SSR has failed to deliver thousands of tons of ingots for the "800" rolling mill.

The enterprise itself is not without its own internal deficiencies. The leaders of the enterprise are slow to develop its transportation. Due to the fault of maintenance workers, who have dragged out their work for an intolerable length of time, blast furnace number one operated below its capacity for two years.

At the "Krasnyy Oktyabr'" Metallurgical Plant in Volgograd "PRAVDA" correspondent V. Goncharov was told that the main reason for this plant's shortfall is disproportion in development of the enterprise. Steel smelting production last year was 78,000 tons greater than in 1975. But rolling mill production, to all intents and purposes, showed no growth during this period. The rolling mills in operation do not provide the required productivity and they frequently break down. And here is the result: the plant has fallen in arrears for 39,000 tons of rolled iron since the first of the year. Shortfalls have also been allowed in production of steel. The USSR Minchermet [Ministry of Ferrous Metallurgy] is

not assisting the enterprise in solving its problems of technical re-equipment. The Volgograd workers are also being let down by their suppliers. Specifically, the Karaganda Metallurgical Combine is in arrears for cast iron and the Chelyabinsk Combine owes them steel ingots.

The Rustavi Metallurgical Plant emerged from competition in first place and won the challenge banner of the USSR Minchermet and the trade union central committee for 17 quarters in a row. Now it has failed to meet its quarterly goals. Kirovo failed to deliver 30,000 tons of ore-concentrate ingots and Voroshilovgrad failed to deliver coal concentrate.

As plant director O. Suladze told our Georgian SSR correspondent, G. Lebanidze, the collective is filled with determination to overcome its shortfall by the end of the year and fulfill its plan and obligations. However the collective is worried about the future of the enterprise. The sintering plant is morally and physically obsolete and beyond reconstruction. But, due to unsatisfactory financing and material-technical supply, the timetable for completing construction on a new one has been broken more than once. Re-equipment of the blast furnace, open hearth and rolling plants has also been dragged out. And if these problems are not resolved future breaks in rhythm will be unavoidable....

These six reports from our correspondents paint a rather spotty picture of the problems and difficulties encountered by ferrous metallurgy workers. But still they have much in common.

This branch of industry has evidently lessened its attention to development of socialist competition, first of all, among cooperating collectives. "With uncommon ease" they default on reciprocal obligations and fail each other as well as their customers. Rich traditions, nurtured within this industry for many years, have been to a significant degree lost. The "rear area" of many plants has fallen behind. Labor and technological discipline as well as responsibility of personnel in various branches leave room for improvement. Many important provisions of the resolution, adopted by the CPSU Central Committee and the USSR Council of Ministers in 1977, "On Measures for Further Development of Non-Ferrous Metallurgy in Accordance with Decisions of the 25th CPSU Congress," have not yet been implemented.

One would like to hope that this shortfall in ferrous metallurgy is a temporary phenomenon and that this leading branch of industry will arrive at the end of the year and this five-year plan with high indicators, satisfying the needs of our national economy.

[35-12184]

12184
CSO: 1842

METAL RESERVES IN THE OCEAN DISCUSSED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Nov 79 p 2

[Article by Professor B. Yegiazarov (Leningrad), Chief Geologist of Sevmorgeo Scientific Production Association, Doctor of Geological-Mineralogical Science: "Toward Marine Metal Reserves"]

[Text] Some scientists think that the earth's reserves of many metals will be depleted earlier than its fuel and energy reserves. This means that it is already time to be concerned with the future. It is fortunate that mankind has such a potential source of metals as the bottom of our seas and oceans. First of all the shelf -- the shallow part of the ocean that lies along the coastline.

Every year rivers bring hundreds of millions of tons of sand to the ocean. Along with the sand they bring many thousands of tons of metals. Ancient and modern-day deposits of titanium, zirconium, iron, tin and gold were formed in this way. It is more profitable to develop these deposits than to mine ores on land. Here there is no need to remove a covering layer of barren rock or destroy tillable and pasture lands. There is no need to create tailings and refuse dumps, which also occupy large areas of valuable land, or to build railroads, highways and access roads.

Prospecting for marine mineral deposits is just beginning. The pace of its idustrial adoption is being held back primarily by insufficiently developed technology. However, in some states, which unlike our country do not have large mineral reserves on land, development of off-shore deposits has been under way for a number of years. The most intensive efforts to prospect for cassiterite (tinstone) are being made in Indonesia. Ocean dredges extract more than 6,000 tons of concentrate here each year. Numerous mineral beds -- of magnetite, ilmenium, rutile, zirconium and monazite -- are being developed in Japan and Australia. Some countries are exploiting deposits of building minerals. Exploration provides evidence that deposits of valuable hard minerals may be discovered in the shallow shelf areas of the USSR.

Exploitation of marine deposits involves a difficult and complex body of work which includes geological survey of the shelf, scientific forecasting, exploration, prospecting and mining of the beds that are found.

The main purpose of a geological survey of the shelf, just as a survey of any area on land, is to create a geological map which serves as a source of objective and comprehensive information. This map serves as a reliable base for scientific forecasting and discovery of mineral deposits. Many large deposits have been discovered and ore-bearing regions and branch points, oil, gas and coal basins have been isolated and mapped during the geological survey process itself. For these reasons, geological survey of the shelf of the USSR should be upgraded to the status of a state geological survey. Forecast appraisal and exploratory prospecting work is now being done on the country's shelfs. The Marine Geological Administration of the RSFSR Ministry of Geology has discovered and is exploring several composite deposits which contain titanium, tin, zirconium and other valuable metal ores. According to preliminary estimates, development of the composite deposits in the maritime regions would be altogether profitable. Valuable metal deposits have discovered in the shelf areas of the north-eastern seas by the Sevmorgeo [Northern Maritime Geological Association] and VNIIMorgeo [All-Union Scientific Research Institute of Maritime Geology and Geophysics].

In essence, the quest for off-shore mineral deposits means the birth of a new field -- marine geological prospecting. Its development requires fundamentally new theoretical, technical and organizational decisions. The primary directions for scientific-technical, design and geological prospecting efforts to evaluate the metal-yielding potential of the shelf areas of the Soviet Union were set forth by the coordinated plan of the USSR State Committee for Science and Technology and the problem plan of the USSR Ministry of Geology for the 1976-1980 period. In accordance with these documents the Sevmorgeo Association, as the head organization in the field of "sea and ocean hard minerals" and in cooperation with organizations of other departments, developed a composite program of scientific-research, experimental-methodological and geological prospecting work. Specialized marine organizations of the USSR Ministry of Geology, RSFSR Ministry of Geology, USSR Ministry of Non-Ferrous Metallurgy, problem laboratories and faculties of many of the country's institutions of higher learning and also laboratories of the institutes of the USSR Academy of Sciences' Far Eastern Scientific Center are all taking part in realization of this program.

The area covered by the shelfs of the USSR totals several million square kilometers. This is not much less that the entire continent of Australia. Much diverse technical equipment is required to conduct operations over such expanses. First of all, of course, it requires specialized geological-geophysical vessels and floating drilling rigs for both arctic and subarctic conditions. Photo-television observations and underwater exploration using manned and automatic submarine equipment could be of great use.

Practice has shown that high results are yielded by composite geophysical explorations: seismic reconnaissance, electronic reconnaissance, gravel survey, radiometric survey and hydromagnetic observation. It is essential that serial equipment be created for these explorations as well as means for affixing radionavigational data, without which the observations lose their value.

On land it is sometimes sufficient for a geologist to bend down, pick up a stone and examine it. But if he wants to examine rock at sea he cannot do it without submarine equipment, samplers and drills.

Unfortunately, in most cases the instruments and equipment for marine geological work exist only in working models. The reasons for this are many and varied.

This work is now under way in various organizations of the country. Separate mock-ups and experimental models of marine equipment are being built, for example, in laboratories of the Moscow and Leningrad Mining Institutes, the VNIIPIGORtsvetmet [All-Union Scientific-Research and Design Institute of Mining Non-Ferrous Metals] of the USSR Ministry of Non-Ferrous Metallurgy, the Institute of Geological Prospecting imeni S. Ordzhonikidze, the Institute of Electrical Engineering for Communication imeni Bonch-Bruyevich, the Pacific Ocean Branch of the Maritime Geological Administration, the VNIIMorgeo, the Sevmorgeo and the Yuzhmorgeologiya [Southern Maritime Geological] Association. But the work is progressing slowly.

It is essential, in my opinion, that a unified service by created in the USSR Ministry of Geology system for creation of low-serial production of technical means which will ensure systematic study and industrial exploitation of the mineral resources of the vast shelf areas of our country. A specialized design bureau with experimental production capabilities must be set up to develop and test models and produce small series of devices and equipment for marine geological prospecting work -- on the shelf and all the world's ocean area.

Considerable funds will be required to provide maritime geological prospecting projects with specialized and drilling vessels, equipment and apparatus. The USSR Ministry of Geology and USSR Gosplan must make provisons for these funds in their plans for the 1981-1985 period. Construction of vessels equipped with the latest navigational and geophysical equipment and drilling rigs should already be included in the plans of the Ministry of Shipbuilding Industry, the Ministry of Instrument Making, Automation and Control Systems Equipment and other departments involved in the previously coordinated program.

It seems rational to combine the efforts of the USSR Ministries of Geology and Non-Ferrous Metallurgy for resolution of technical and technological problems. They have already concluded an agreement on scientific cooperation which provides for development of methods and creation of technical

means for exploration, prospecting and industrial exploitation of the hard mineral deposits on our continental shelf. They have established joint bases, test ranges and expeditions. This step may be considered the beginning of a much larger program projected for the long term.

Rapid development of marine geological prospecting will facilitate exploitation of the mineral resources under our seas and oceans and put them into the service of our country's national economy.
[38-12184]

12184
CSO: 1842

COBALT PRODUCTION REPORTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Nov 79 p 1

[Article by TASS correspondent R. Trusov: "Outrunning Time"]

[Text] A cobalt "ingot" costing hundreds of thousands of rubles was produced for the Anniversary of the Great October Socialist Revolution at the Noril'sk Mining-Metallurgical Combine. Such valuable metal has been additionally smelted above the plan at the enterprise since the beginning of the year.

Intertwining of many kilometers of various colored pipes and small, seemingly toy furnaces is what the chlorinated cobalt shop looks like, the most complex at the enterprise. Hydrometallurgy, chemistry and flame smelting are joined into a single unit here. The precision of all the processes is that of a jeweler. This is also confirmed by the State Badge of Quality, by which all five types of products from the shop have been noted.

"We recently completed reconstruction," says the deputy chief of the shop N. Pomolov, "which permitted us to double product output. The hydrometallurgical division now operates continuously and all processes for producing the necessary solutions are monitored automatically."

The work of the smelters here is complex, like a jeweler's work, but high professional skills permits them to outrun time. For example, V. Ivanov's brigade completed the plan of four years of the five-year plan during the pre-holiday days, becoming the winner of the shop competition in honor of the 62nd anniversary of the Great October Socialist Revolution.

During this five-year plan, Noril'sk became the main supplier of cobalt in the country. The metal is shipped from here to more than 200 addresses. [54-6521]

6521
CSO: 1842

USSR UDC 539.4

THE EFFECT OF TUNGSTEN CARBIDE ON THE CREEP OF ZIRCONIUM CARBIDE

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 10, Oct 79
pp 1775-1778 manuscript received 3 Aug 76

KATS, S. M., ORDAN'YAN, S. S., GORIN, A. I., SEMENOV, S. S. and KUDRYASHEVA, L. V., Leningrad Technological Institute imeni Lensovet

[Abstract] The effect of dissolved WC on the creep parameters of ZrC-base solid solutions was investigated on samples containing up to 12% WC. Samples were produced from powders under a dry pressure of 1 ton/cm^2 and then vacuum sintered at 2100°C for one hour. After sintering, the samples were annealed at 2400°C with several samples annealed at 2500-2900°C. After the samples were subjected to a compressive stress of 1-5 kG/mm^2 it was noted that the concentration relationship of creep rate had a minimum belonging to alloys containing 5-6 mol% WC which was 1/8 to 1/12 that of ZrC. The creep activation energy for temperatures up to 2800°C was 174±18 kcal/mol and was relatively independent of the amount of WC. At temperatures above 2650°C, creep was linear while at lower temperatures it was barely perceptible. Figures 3; references 9: 7 Russian, 2 Western.
[48-6368]

USSR UDC 669.3:620.18+620.17:669.721'71'5

EFFECT OF COPPER ON THE STRUCTURE AND PROPERTIES OF ALLOYS OF THE Mg-Al-Zn SYSTEM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 10, 1979 pp 59-61

YEAHOV, A. A., LALAYAN, E. A. and SHMUYLOVICH, A. R.

[Abstract] The effect of treatment with minute amounts of copper on the structure and properties of cast alloys of the Mg-Al-Zn system was investigated. The alloys were melted in a 3-kg steel crucible within an electric laboratory furnace. Copper was added in the form of an Al-Cu master alloy containing 50% Cu. The charge was then cast into chill molds from which specimens were cut out and tested. Treatment of the alloys with up to 0.5-0.8% Cu increased their yield point by 3-5 kg/mm^2 owing to the comminution of the eutectic component (the β phase, or $Mg_{17}Al_{12}$ phase), which resulted in a fuller and more uniform saturation of the solid solution with the elements constituting the β phase during pre-quench heating. The positive effect of copper on the strength properties of alloys of the Mg-Al-Zn system is chiefly due to the action of copper as an agent promoting the dissolution of aluminum in these alloys during homogenizing. Figures 6.
[23-1386]

USSR UDC 669.293

EFFECT OF TITANIUM, ZIRCONIUM, AND CARBON ON THE HIGH-TEMPERATURE STRENGTH AND EMISSION PROPERTIES OF TUNGSTEN

Moscow IVUZ. MASHINOSTROYENIYE in Russian No 10, 1979 pp 106-109 manuscript received 13 Jul 77

ARZAMASOV, V. B.

[Abstract] The effect of alloying and temperature on the high-temperature strength and work function of tungsten alloys of the W-Ti, W-Zr, and W-Zr-C systems was investigated. It was found that treatment of tungsten with minute amounts of Ti (0.12 wt.%), Zr (0.09-0.11 wt.%) and C ($\leq$0.05-0.010 wt.%) raises its recrystallization temperature and increases its high-temperature strength. The maximum effect is produced by joint treatment with 0.1% Zr and 0.01% C which, at 1000-1800°C, form the carbide phase ZrC resulting in a 3- to 4-fold increase in high-temperature strength compared with untreated tungsten. It is established that titanium, when added in the amount of 0.1 wt.%, has virtually no effect on the work function of tungsten. For W-Zr and W-Zr-C alloys at 1700-1900°C emission from cathodic surfaces is similar to emission of materials with low work function. At $\geq$ 1800-1900°C emission comes close to the emission of the pure substrate material, since the activating zirconium film gets vaporized from the cathodic surface. Figures 3; references 5 (Russian). [18-1386]

USSR UDC 669.35

EFFECT OF THE STRUCTURAL FACTOR ON STRESS RELAXATION IN COPPER ALLOYS

Moscow IVUZ. MASHINOSTROYENIYE in Russian No 10, 1979 pp 114-118 manuscript received 30 Jan 78

TKHAGAPSOYEV, KH. G. and TSAGOV, KH. A.

[Abstract] Moderately loaded flexible components are often liable to failure owing to stress relaxation following their hardening. Hence relaxation resistance (RR) is a factor to be considered in order to reduce risk in the selection of materials and in hardening techniques. In this connection the effect of work hardening on the RR was investigated with respect to the copper-based spring alloys BrOF6.5-0.15, BrOTs4-3, BrKMts-3-1, MNTs15-20, BrB2, and BrBNT1.9, which are widely used in the manufacture of flexible components of machinery and instruments. The product of the temperature modulus of elasticity and the elastic limit was used as the criterion of RR. In these terms, the maximum RR was displayed by beryllium bronze BrB2 and the minimum, by silicon-manganese bronze BrKMts3-1. Figures 2; references 3 (Russian). [18-1386]

USSR UDC 535.211

ON THE EVALUATION OF DECREASING THE INTENSITY OF PLASMA LASER RADIATION NEAR THE SURFACE OF SOLID TARGETS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 79 pp 3-6 manuscript received 1 Mar 78

UGLOV, A. A. and GNEDOVETS, A. G., Moscow

[Abstract] A study was made of the weakening of laser radiation intensity caused by refraction and absorption of a laser beam by a plasma formed near the surface of a solid target. The effect of electron density distribution, dimensions and propagation of the plasma sheaf by the laser beam on the characteristics of the heat source acting on the irradiated target surface was evaluated. The regions of charge of electron concentration and their gradients were determined in the limits of which the mechanisms of refraction and absorption of laser radiation by the plasma cloud act. Figures 2: references 3: 2 Russian, 1 Western. [25-6368]

USSR UDC 539.216.2:537.52

FEATURES OF METALLIC FILM ACICULAR STRUCTURE DURING ELECTRON-BEAM PLASMA SPRAYING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 79 pp 51-55 manuscript received 18 Dec 78

GUSEV, O. V., ROSLYAKOVA, T. L. and SHORSHOROV, M. KH., Moscow

[Abstract] The method of transmission electron microscopy was used to investigate the features of acicular structure of silver and aluminum films on KCl and Si substrates during electron-beam plasma spraying (EBPS) using an accelerating potential of -1.5 kV. The high energy of neutral atoms and the presence of high-energy ions in the vapor flow during EBPS promotes a significant lowering of the epitaxial film-growth temperature on alkaline-haloid crystals in comparison with thermal vaporization. Silver films, condensing on the KCl chips, revealed a well expressed epitaxial orientation $(001)_{Ag}//(001)_{KCl}$ even without preheating of the substrate, whereas in the earliest stages of condensation the process of coalescence occurs, leading to diminished acicular density and increased acicular size. On a silicon substrate the silver film has a primarily $(111)_{Ag}//(111)_{Si}$ orientation, being azimuthally

disoriented from the point of epitaxial orientation and the acicular density is four times greater than on KCl. Aluminum films, sprayed on Si at room temperature to a thickness of 20Å, are continuous with a highly dispersed structure and no primary orientation. Figures 5; references 7: 6 Russian, 1 Western.
[25-6368]

USSR UDC 621.746:669.111.2

ANOMALOUS GRAPHITE IN CASTINGS OF HIGH-MAGNESIUM GRAY IRON: REPORT 2

Moscow IVUZ: CHERNAYA METALLURGIYA in Russian No 9, Sep 79 pp 112-114
manuscript received 21 Jun 78

VORONTSOV, V. I., BESPALOV, N. S. and MIKHAYLOV, A. M., Moscow Institute of Steel and Alloys

[Abstract] A solution is still sought to the problem of producing large castings of high-magnesium gray iron with stabilized globular rather than anomaloys vermicular graphite at the center. Experimental studies concerning this problem include controlled melting and subsequent oriented crystallization with graphite in either form. Here globular and vermicular graphite were produced by holding the melt at 1340-1400°C for 5 minutes and 40 minutes respectively. The area of the graphite-austenite interface, per unit volume of graphite, was determined by microscope measurements and calculations. An analysis of the casting process and examination of the microstructure indicate that anomalous graphite structures form in hot spots of a casting due to changes in the crystallization rate which do not allow sufficient time for carbon migration and due to the reduced effectiveness of graphitizing-spheroidizing additives. It appears necessary to provide more graphite nucleation centers during both the initial and the final stages of the crystallization process, namely by using modifying additions capable of remaining active for longer periods of time. Figures 2; references 4: 3 Russian, 1 Western.
[50-2415]

USSR UDC 669.018.2:620.17

EFFECT OF DEFORMATION ON THE PHYSICO-MECHANICAL PROPERTIES OF INVAR

Moscow IVUZ: CHERNAYA METALLURGIYA in Russian No 9, Sep 79 pp 106-108
manuscript received 4 May 79

BASHNIN, YU. A., ULANOVSKIY, F. B. and SHIRYAYEVA, A. N., Moscow Evening Metallurgical Institute

[Abstract] A study was made to determine the effect of cold working on the temperature coefficient of linear thermal expansion and on some mechanical properties characterizing invar, an iron-nickel alloy used as the passive component of bimetals. Grade 36N invar has the minimum thermal expansivity after quenching from 830°C in water with subsequent tempering for 1 hour at 315°C and aging for 48 hours at 95°C. Specimens with 35, 36, and 37% Ni respectively, within the applicable GOST specifications, were tested at room temperature for tensile strength, 0.2% yield strength and Brinell hardness after cold rolling with various levels of deformation from 20 to 80%. All mechanical properties were found to improve with increasing deformation, regardless of the nickel content but most appreciably in the case of the 37% Ni alloy. The temperature coefficient of linear thermal expansion was found to depend also on the temperature range and, on this basis, the 36% Ni alloy loses its invar properties at temperatures above 250°C. Figures 1; references 2 (Russian).
[50-2415]

USSR UDC 620.181

FEATURES OF THE EFFECT OF HIGH-TEMPERATURE DEFORMATION ON THE KINETICS OF BAINITE TRANSFORMATION IN STEEL OF VARIOUS COMPOSITION

Moscow IVUZ: CHERNAYA METALLURGIYA in Russian No 9, Sep 79 pp 101-105
manuscript received 24 Oct 78

KHLESTOV, V. M., GOTSULYAK, A. A., ENTIN, R. I., KONOPLEVA, YE. V. and KOGAN, L. I., Zhdanov Institute of Metallurgy

[Abstract] A study was made concerning the anomalous effects of hot rolling, at 800°C after heating to 950°C, on the kinetics of bainite transformation in steel. Eight grades of steel were considered in the experiment, differing either in the carbon content only (0.1-0.4%) or also in the alloying elements (nickel, chromium, molybdenum). The results indicate that hot rolling can either inhibit or accelerate subsequent bainite transformation. A lower temperature of isothermal heat

treatment, a higher carbon content, and addition of carbide-forming elements will inhibit it. Activation of grain nucleation processes, possibly stimulated by large distortions of the non-uniform carbon concentration profile, will accelerate it. Figures 2; references 12 (Russian).
[50-2415]

USSR UDC 621.791.76

A STUDY OF THE INTERACTION OF IRON AND TITANIUM UNDER A PULSE LOAD

Moscow IVUZ: CHERNAYA METALLURGIYA in Russian No 9, Sep 79 pp 92-94
manuscript received 7 Jun 78

RYABCHIKOV, YE. A., RYABCHENKO, T. G., SOLOV'YEV, V. YA. and EPSHTEYN, S. N., Moscow Institute of Steel and Alloys

[Abstract] A study was made to determine the structure of the transition layer in iron-titanium bimetal strips formed during impact welding. The physical process parameters influencing that structure include impact time and peak pressure at the shock wave front. Welding was done in the parallel configuration, with the bottom strip on the sand base and the top strip dropped upon detonation of an explosive charge of ammonite mix. Subsequent metallographic examination, after heat treatment or service, covered the "white" phase consisting of two intermetallic compounds: FeTi and Fe_2Ti. The depth of iron penetration and the iron distribution in titanium were determined on the basis of x-ray microspectrographic measurements and x-ray structural analysis, following a vacuum anneal of specimens at temperatures from 750 to 1050°C. Figures 3; references 2 (Russian).
[50-2415]

USSR UDC 669.017.3

MORPHOLOGICAL ANOMALIES OF CARBURIZED IRON ALLOYS

Moscow IVUZ: CHERNAYA METALLURGIYA in Russian No 8, Aug 79 pp 92-95
manuscript received 24 Feb 78

MOVCHAN, V. I., PEDAN, L. [illegible] and GERASIMENKO, V. P., Dnepropetrovsk Institute of Metallurgy

[Abstract] A study of carburized iron alloys with α-phase producing carbide forming element (molybdenum, tungsten, vanadium, chromium, titanium), was made for the purpose of determining the effect of various

factors on the structurization during the 3-phase reaction of ferrite breakup into austenite and carbides. In the case of normal breakup with a compatible growth of austenite and carbide grains in plastic bacillary clusters, a higher alloy content widened the temperature range of such growth but also required a higher carburization temperature. Anomalous breakup inhibited compatible growth and produced disperse structures of carbide inclusions. The structurization also depended on the initial carbon content and the carburization temperature, a compatible cluster structure being formed, typically, during carburization at 1100°C to increase the initial carbon content to 0.05%. Figures 4: references 2 (Russian).
[51-2415]

CSO: 1842

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No. 67

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 67

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USSR

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DEVICES FOR TESTING THIN FIBERS AND WIRE FOR HEAT RESISTANCE

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 45, No 11, Nov 79 pp 1055-1057 manuscript received 4 Oct 78

KOSAREV, A.I., KOSAREV, YE.A. and NEYMAN, S.M.

[Abstract] Two special devices have been built with which thin fibers made of inorganic materials and thin wire made of a refractory metal can be tested for heat resistance. The first device is intended for high-temperature tests in air or in an inert atmosphere. It consists essentially of a cylindrical guide rod with a tensile loading mechanism and a beaker inside a vertical tubular furnace. It is designed for simultaneous testing of several specimens in different atmospheres at the same temperature and under the same or different tensions. The second device is intended for testing under vacuum and represents an appropriately modified tensile testing machine with a crossarm and clamps installed, after assembly, inside a vacuum test chamber. Both devices are built with heat resistant materials. They have been used for measuring the life-stress characteristics of SiC fibers 0.08-0.1 mm in diameter (at 1023-1123°K in air) and of tungsten wire 0.1 mm in diameter (at 1373°K under 10^{-4}-10^{-5} mm Hg) respectively. Figures 4; references 1 Russian.
[83-2415]

USSR

UDC 539.4+666

CONCERNING THE ACCURACY OF PROCESSING RESULTS OF CERAMIC BEND TESTS

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 79 pp 51-54 manuscript # received 26 Jul 78

GRUSHEVSKIY, YA. L., Kiev, Institute of Problems of Strength, Academy of Sciences UKrSSR

[Abstract] A method is described for approximating and differentiating load-strain curves which can be used to determine the bend strength of ceramics with consideration of the non-linearity of deformation curves and the differences in the mechanical behavior of materials under tension and compression. Alumina + titanium oxide, alumina + zirconium silicate, zirconium oxide + hydrogen phosphate + calcium oxide and carborundum refractory M7 were used as subject materials to determine the strain derivative E'. The algorithm for performing the above is discussed and

the mathematics developed. It was found that neglecting the nonlinearity of the strain diagram and differences in the deformation of these ceramics leads to errors that are 2-3 times greater than for the generally accepted method. Figures 4; references 6: all Russian.
[57-6368]

USSR

UDC 669.1.017:669.018.29

COMPOSITE MATERIAL WITH A MATRIX OF HIGH-CHROMIUM IRON

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11 Nov 79 pp 6-8

PONOMARENKO, V. P., STOYKO, V. P. and SHVARTSER, A. YA., Donets Polytechnical Institute

[Abstract] A technology for introducing reinforcing particles into a high-chromium iron matrix developed by the authors uses electroslag surfacing to distribute the particles close to the matrix surface for improved wear resistance. Rhelite [WC+W_2C eutectic] grains were used as the reinforcing particles. A study was made of the interaction of the particles with the matrix to determine the effect on matrix structure and hardness. Complex W and Cr carbides were formed by interaction of the matrix and reinforcing particles which in turn formed eutectic and hypoeutectic structures. A carbide shell formed around each reinforcing grain, providing very high microhardness. As the distance from the shell increased, microhardness diminished but strength increased. Therefore, if the reinforcing particles are positioned uniformly at specific distances from each other, the composite material will have high hardness for wear resistance and sufficient strength to sustain shocks during operation. Figures 3; references 2: both Russian.
[55-6368]

USSR

UDC: 678.5.06:678.2

INFLUENCE OF HEAT TREATMENT OF THE MATRIX ON THE MECHANICAL PROPERTIES OF CARBON-REINFORCED PLASTIC

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep/Oct 79 pp 925-929, manuscript received 15 Mar 79

ZHIGUN, I. G., MOROZOV, O. A., RADIMOV, N. P., Institute of Polymer Mechanics, Academy of Sciences Latvian SSR, Riga; All-Union Scientific Research Institute of Artifical Fibers, Moscow Oblast

[Abstract] A study is made of a method of improving the shear properties and tensile and compressive strength of carbon-reinforced plastic in the direction transverse to the unidirectional reinforcing filaments by creation of rigid coupling between the reinforcing fibers. These couplings were formed by heat treatment of the polymer matrix, type 5-211B epoxy-phenyl

binder or phenyl-formaldehyde binder, reinforced with LU-3 strips. The process includes the following main operations: production of the initial carbon-reinforced plastic; heat treatment of the binder; saturation of the material with binder under a vacuum and under pressure after heat treatment with subsequent curing. Figures 5; references 7: all Russian.
[39-6508]

USSR UDC: 539.43:678.5.06

LONG-TERM FAILURE OF INELASTIC COMPOSITES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep/Oct 79 pp 794-798, manuscript received 2 Feb 79

SUVOROVA, YU. V., VIKTOROVA, I. V., MASHINSKAYA, G. P., Moscow

[Abstract] A model developed earlier is used to show how irreversibility, appearing in the deformation of composites, may be related to gradual accumulation of damage occurring upon loading. The addition of the corresponding failure criterion allows prediction of the time to rupture by analysis of deformation diagrams. The model allows separation of the processes of viscous flow and of accumulation of damage in the material, and the fracture criterion allows rather precise prediction of long-term failure on the basis of much shorter experiments. The model can also be applied to other loading conditions, for example, fatigue. Figures 4; references 14: 12 Russian, 2 Western.
[39-6508]

USSR UDC 620.171.3:669.721+669.14+669.781

STUDY OF THE FRACTURE PROCESS IN MAGNESIUM-BASE COMPOSITE MATERIALS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 16-17

MAKSIMOVICH, G. G., LYUTYY, YE. M., YELISEYEVA, O. I., KADYROV, V. KH. and GORDIYENKO, A. I., Physicomechanical Institute, Ukrainian Academy of Sciences, L'vov, and the Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] Features of the fracture process were studied for magnesium-base composites of the ductile matrix-ductile fiber and ductile matrix-brittle fiber types at 20-400°C. MPF4 magnesium powder was reinforced with Kh13N13M2 steel fibers (ductile) 140 microns in diameter and boron fibers (brittle) 90 microns in diameter. The strength properties of the Mg-B composite were higher than the Mg-steel composite; at increased temperatures the tensile and yield strengths of both materials were diminished. Ductility of the Mg-steel composite was higher; starting at 200°, it improved with increased temperature, whereas ductility of the Mg-B material remained unchanged. Fractograms of the Mg-B material showed that the boron fibers were the source of failure of all test temperatures. Fracture of the magnesium matrix occurred via a ductile mechanism at all temperatures and at elevated temperatures compound crushing of the boron fibers in the fracture zone was observed. Also noted was an intensification of deformation at the fiber-matrix interface leading to crack development and subsequent failure. Figures 3; references 4: 2 Russian, 2 Western.
[55-6368]

USSR UDC: 666.539.2 9.3

STUDY OF PROCESSES OF MASS TRANSFER IN COMPOSITE MATERIALS WITH DIFFUSION BONDING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 129-132, manuscript received 21 Apr 79

KRISHTAL, M. A., GONCHAROV, V. S., SHTEYN, L. M., Tol'yatti

[Abstract] A detailed study is presented of the diffusion bond in composites whose components are compatible in physical and chemical properties. The study was performed by creating a diffusion element in the iron-cobalt and iron-chromium systems. The method of x-ray microanalysis was used to study the kinetics of growth of the diffusion interlayer. The parameters of mutual diffusion served as the initial material for calculation of the kinetics of interaction between the parameters during the course of time. The experiments can serve as a basis for estimating the compatability of components of composites, the structure of the division boundary in composites and their physical-chemical properties. Figures 4; references 2: both Russian.
[64-6508]

USSR UDC: 621.791.3:669.018.9

PECULARITIES OF SOLDERING OF ALUMINUM-BASED COMPOSITES

Moscow SVAROCHNOYE PROIZVODSTVE in Russian No 8, Aug 79 pp 15-16

GRISHIN, V. L., Candidate of Technical Sciences, VOLCHKOV, A. N., ALDOSHIN, YE. V., Engineers

[Abstract] This work studies the specific features of the process of production of solder joints in aluminum-based composite materials. The studies were performed on plates of VKA-1 alloy 0.8-1.5 mm thick containing 43-50% boron fibers by volume, as well as this material plus OT4 titanium alloy 2.0 mm thick. The vacuum soldering methods were used with a composite solder consisting of a silumin eutectic and an aluminum alloy containing magnesium. Heat sources for local heating during soldering and solders with melting points of 450-500°C should be used to preserve the strength properties of the composite materials. Photographs are presented of the microstructure of the metal of solder joints of VKA-1 and VDA-1 plus OT4. Figures 1; references 4: 1 Russian, 3 Western.
[45-6508]

USSR UDC: 537.4:678.5.06

EXPERIMENTAL ESTIMATE OF STRENGTH ANISOTROPY IN UNIDIRECTIONAL REINFORCED ORGANIC PLASTIC

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, Sep/Oct 79 pp 799-803, manuscript received 13 Mar 79

SOKOLOV, YE. A., Institute of Polymer Mechanics, Academy of Sciences, Latvian SSR, Riga

[Abstract] An experimental study is performed of the strength of a unidirectional plastic based on organic fibers and an epoxy binder with a reinforcement factor of 0.64. The work was performed in the following sequence: the short-term strength of the material was determined with various types of stresses; the strength surface determined from the experiments was described for the case of a flat stress state; finally, the anisotropy of strength of the material in tension and compression was estimated. Cross sections of the strength surface of the material in three planes are presented. The data produced indicate that it is possible to describe the strength of the material studied by means of a second-order surface equation containing linear and quadratic terms. The results of the work can be used

to estimate the strength of multilayer organic plastics of this type if a unidirectional reinforcing layer is used as the primary structural element of the material. Figures 2; references 28: 26 Russian, 2 Western [39-6508]

UDC 620.194

USSR

ENHANCING THE PASSIVABILITY AND ACID RESISTANCE OF TITANIUM AND STAINLESS STEELS BY MEANS OF THEIR ELECTROSPARK DIFFUSION PLATING WITH PALLADIUM

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 6, 1979 pp 651-655 manuscript received 22 May 78

TOMASHOV, N. D., CHERNOVA, G. P., RESHETNIKOV, S. M., FEDOSEYEVA, T. A., VDOVIN, S. F. and KORNIYENKO, L. P., Institute of Physical Chemistry, Academy of Sciences USSR

[Abstract] Specimens of stainless steels and titanium were experimentally subjected to electrospark diffusion plating with a 5-um-thick layer of palladium. The specimens were tested for chemical behavior and corrosion resistance in solutions of aggressive acids (20-40% H_2SO_4 and HCl) at 20-100°C. Diffusion placing with palladium was found to shift the potentials of the steels and titanium into the passive region. Thus, for example, non-coated Kh25 steel in 20 and 40% H_2SO_4 displays a potential of the order of -0.34 to -0.35 volt, which corresponds to its active state and low corrosion resistance, whereas the steel coated with palladium displays potentials of 0.5 volt in 20% H_2SO_4 and 0.6 volt in 40% H_2SO_4, which correspond to a passive state and full corrosion resistance of the steel. In general, it can be concluded that cathodic electrospark deposition of such alloy elements as Pd, Ru, Pt and others on a thin surface layer (1-20 um) of stainless chromium and chromium-nickel steels, as well as of titanium and its alloys, can markedly enhance their passivability and corrosion resistance while at the same time reducing the expenditures of expensive alloy elements to 1 g/m^2. This method can also be used to increase the acid resistance of discrete surfaces on finished structural components fabricated from these alloys, e.g. the inside surfaces of containers, flanged joints, etc. Figures 4; references 17: 13 Russian, 4 Western.
[69-1386]

USSR UDC 621.357.7

STABILITY OF PASSIVE

STATE OF TITANIUM IN HNO_3-CONTAINING CONCENTRATED HYDROCHLORIC ACID

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 6, 1979 pp 684-686 manuscript received 24 Jul 78

KOPELNOVICH, D. KH. and IVLEV, V. I.

[Abstract] Nitric acid had been recommended as an inhibitor to protect titanium against corrosion in HCl. However, after some time of operation in concentrated (35 mass%) HCl treated with HNO_3 (40 g/liter), intensive corrosion of titanium had been observed. To investigate the cause of this accelerated corrosion, commercial titanium (VT1-0) was placed in concentrated HCl (25-35%) solutions containing from 0.5 to 40 g/liter HNO_3. The minimum necessary HNO_3 concentration assuring a stable passive state was determined as a function of the ability of titanium to get passivated after 5 min of cathodic polarization in the presence of a potential of -0.25 volt. For 35% HCl the minimum necessary concentration of HNO_3 was 18 g/liter, and for 30% HCl, 7 g/liter. However, prolonged exposure of HNO_3-passivated titanium in HCl solutions was found to result in a sharp displacement of the potential to the active region and acceleration of corrosion. Analysis of the solutions showed that the HNO_3 concentration decreases with increase in storage time, clearly owing to its reduction by HCl ($3HCl + HNO_3\ 2H_2O + NOCl + Cl_2$), thus resulting in the accelerated corrosion of titanium. Thus, either the time of contact between a given portion of the solution and titanium equipment should be limited or more nitric acid should be periodically added to the solution. Figures 1; references 3: all Russian. [69-1386]

USSR UDC 620.199

BEHAVIOR OF TITANIUM-PALLADIUM ALLOY IN CREVICE AND IN BULK SOLUTION OF CHLORIDES

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 6, 1979 686-688 manuscript received 24 Jul 78

KURNOSIKOVA, V. N. and GORBACHEV, A. B., State Scientific

Research and Project-Design Institute of Basic Chemistry

[Abstract] The electrochemical behavior of "4200" Ti-Pd commercial alloy in crevice and bulk 5.3n NH_4Cl + 1.4 n. NaCl at 100-200°C was investigated, on conducting anodic polarization through every 0.1-0.2 volt from the corrosion potential. The alloy was found to display a high resistance to crevice corrosion and pitting corrosion in aerated and deaerated solutions.

Reducing the pH of the solution to 1 and subjecting the alloy to hydrogen absorption in crevice do not impede the passivation of the alloy. Laboratory corrosion tests corroborated the high resistance of the alloy under these conditions. During shop repair the alloy was used to build up the shaft-contacting flange surfaces of titanium equipment used in the production of ammonium chloride from the filter liquor of the soda shop. Prolonged operation of the facility with the thus coated flanges in the presence of the solution boiling at 135-140°C demonstrated the absence of crevice corrosion. Figures 1; references 6: 3 Russian, 3 Western.
[69-1386]

USSR

UDC 620.194

PICKLING OF TITANIUM AND KH18N10T STEEL IN SULFATE SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 6, 1979 pp 688-691 manuscript received 25 Nov 77

USOVA, V. V., KASATKINA, A. I. and PLOTNIKOVA, T. P.

[Abstract] When titanium is pickled in sulfate solution, HF or its salts are added, and when stainless steels are pickled, NaCl and $NaNO_3$ are added. When the pickling processes are combined, these ions can be simultaneously present. In this connection, the effect of these additives on the pickling of VT1-1 titanium and Kh18N10T stainless steel in 15% H_2SO_4 was investigated. It was found that in the fluoride-containing solution the potential of nonpolarizable titanium is -0.6 volt and that of steel, -0.16 volt. The dissolution rate of titanium is nearly two orders higher. Against this background, chlorine ions do not affect the polarization and dissolution rate of titanium. As regards the stainless steel, the most rapid removal of scale from steel is achieved in HF-containing solutions, but then treatment with $NaNO_3$ is also necessary, since as little as 2% $NaNO_3$ is instrumental in causing the potential of the steel to become somewhat more positive than zero. Fluorine-containing H_2SO_4 solutions used to pickle titanium can be re-used to pickle stainless steel upon being treated with $NaNO_3$. Figures 2; references 6: 5 Russian, 1 Western.
[69-1386]

USSR UDC 620.193

CORROSION OF METALS IN THE ATLANTIC OCEAN

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 6, 1979 pp 697-700 manuscript received 9 Nov 78

ULANOVSKIY, I. B., Institute of Oceanology, Academy of Sciences USSR

[Abstract] Corrosion tests of St3 carbon steel, Kh18N10T stainless steel, M1 cooper, L63 brass, and AMg-5M and AmtsM aluminum alloys were conducted for 20. 40, and 70 days in the Sargasso Sea by immersing the metal specimens at 16 different depth levels, from 2 to 5000 m and then measuring the weight loss during the periods of immersion. The corrosion of carbon steel was found to decrease with increasing depth, particularly below the 1000 m depth level owing to the lower temperatures and slower currents at these depths and also owing to the increased presence of biogenous elements (silicic acid, nitrites, nitrates, and phosphates) which slow down the corrosion of carbon steel. After 20 days the corrosion rate at the maximum depth decreased by 10-15% in the Atlantic Ocean, compared with a sevenfold decrease in the Pacific. As for copper, at 2-500 m depths its corrosion rate was 0.08 $g/m^2.hr$, whereas below these depths it was only one-third as high. As for brass, it underwent a fairly uniform surface dezincing and its corrosion rate over 20 days was 1.5 times as high. As in the case of copper, subsequent corrosion after 70 days was insignificant. As regards the aluminum alloys, their corrosion rate at lower depths was one-sixth to one-seventh as high as in the 2-500 m layer. As regards the stainless steel, it displayed insignificant corrosion at all depths in the Atlantic compared with its catastrophic corrosion in the Black Sea and moderate corrosion in the Pacific. References 12: 10 Russian, 2 Western. [69-1386]

REASONS FOR UNSTABLE OPERATIONS AT THE DNEPROVSK ORE ENRICHMENT COMBINE

Moscow EKONOMICHESKAYA GAZETA in Russian no 52 Dec 79 p 9

[Article by V. Afonin, director of the Dneprovsk Ore Enrichment Combine, "The Reasons for Unstable Operation"]

[Text] Ore enrichment combines have become the main suppliers of iron-ore raw materials for metallurgical factories. Five such combines (GOKs) operate in the Krivorog basin. The discovery of beds of iron quartzites in Kremenchug rayon was a great success for prospecting geologists. But they require enrichment. The Dneprovskiy GOK has become the leader in exploitation of iron ore raw materials. It became one of the operating enterprises in 1970. Now the combine processes 27,000,000 tons of crude ore and produces more than 11,000,000 tons of concentrate and 5,000,000 tons of pellets.

We will strive to realize the designed outputs of the enterprise as quickly as possible. The average annual production increase in the current five-year plan exceeds fifteen percent.

Construction of the Dneprovskiy GOK is continuing. Expansion of the principal works, the mine and the enrichment plants, is nearing completion. The buildings of a second pelletizing plant are going up.

According to the design, the production outputs must grow, by the end of the current five-year plan, to 34,000,000 tons of crude ore, 14,000,000 tons of concentrate, and 12,000,000 tons of pellets per year. The numbers are impressive. However, a serious obstacle has arisen at the works. The new output goals are not being met at a satisfactory tempo. For several years now, a number of basic problems have not been solved.

One of these problems is the development of the open pit. They have fallen behind from the very first day of operations. According to plan, the first line should have yielded 21,000,000 cubic meters of raw ore per year. The combine did not achieve such a level even nine years after introduction of the first line. In actuality, during all the years of its operation, the strip mining operations are fulfilling only 65 to 68 percent of the planned volume.

What is the chief reason for this situation at the open pit works? The application of high-production ore transporting equipment was envisioned for working the strip mine and extracting the ore: 8-cubic excavators, 75-ton dump trucks, trunk line diesel locomotives with 3,000 horsepower rating and other technology. However, these forecasts are still unrealized.

Almost half of the hauling vehicles are four-cubic excavators, which are badly in need of repair. Twenty-seven ton and 40-ton dump trucks are used for transport of the ore material. Railroad transport is in a worse state of affairs. Two thousand horsepower diesel locomotives were sent to us after being used for a long time hauling steel. To top matters off, the USSR Ministry of Ferrous Metallurgy doesn't have an appropriate repair facility.

This is only one aspect of our troubles. The equipment we do have is not being utilized effectively. After a long delay the builders finally finished construction, in 1978, of the mine repair shops and the diesel car depot. One would think that, after these shops begin functioning, repairs and maintenance of mining, transport, railroad, and other equipment would improve.

However, the repair shop buildings are practically empty. Two-thirds of the machining, forging and pressing, depot, and garage equipment has not been issued by the planning organs and the USSR Ministry of Ferrous Metallurgy. The repair organizations of the ministry do not at all satisfy our requests for centralized repair.

The situation is worsening because of the stingy supplying of spare parts and materials. In the first half of 1979 alone the excavators stood idle waiting for repair for more than 37,000 machine hours, the vehicles waited 75,000 hours, and the diesels waited 22,000 machine hours.

Because of the unsatisfactory amount of strip mining work and the insufficient output of ore, the threat of "straightening out" the strip mine operation hangs over us. What is the way out of this mess? The way out is a sharp increase in the rate of strip mining and in the preparation of ore reserves. The USSR Minchermet is called on to improve the organization of centralized repair of the existing technology. At the combine we have to do much to improve production management and the use of equipment and also to strengthen labor discipline.

The pelletizing plant is not operating consistently. One of the reasons is the lack of designers. The leadership of the combine, together with the UkrSSR Minchermet, is paying greater attention to this plant. Inefficient equipment is being replaced, many sections are being rebuilt, and reserve parts are being manufactured. But the general designer, "Yuzhgiproruda" and the authors of the technology of enrichment, the institites "Mekhanobr" and of pelletizing, "Mekhanobrchermet," have taken an absolutely incomprehensible position. They practically abandoned their own offspring with many shortcomings.

Nevertheless, our leadership is full of optimism. An important part of the five-year plan is being accomplished. A modern town is going up on the shore of the Dnepr. We hope that the interested organizations and institutions, and above all, the workers of the appropriate departments of the Gosplan of the USSR, USSR Gossnab, and USSR Minchermet will help us to overcome our temporary difficulties.
[66-9424]

9424
CSO: 1842

USSR UDC 621.78:620.186:620.17:669.295.5

EFFECT OF HEAT TREATMENT ON THE PROPERTIES AND STRUCTURE OF VT9 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAY.. OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 55-57

SOLONINA, O. P., LYAPICHEVA, N. F. and BILIBINA, YE. N.

[Abstract] The mechanical properties and structural transformations taking place in VT9 alloy were studied in relation to heating temperature, cooling rate, and aging modes for blanks that were water quenched and air cooled. Soaking was done for one hour at 900-1200°C followed by aging at 100-750° for two hours and air cooling. After the above heat treatments were performed on VT9, metastable alpha'-, alpha"- and $beta_M$-phases were formed. In relationship to the quantitative ratios of these phases, their dispersity and precipitation shapes, it is possible to achieve a variety of properties. Maximum strength properties (TS = 140 kgf/mm^2, YS = 125 kgf/mm^2) with satisfactory ductility (E = 10%, RIA = 25%) can be achieved after water quenching from a one-hour soak at 950° and aging for two hours at 530° plus air cooling. Minimum strength properties (TS = 105 kgf/mm^2, YS = 75 kgf/mm^2) and maximum ductility is produced by soaking at 850-900° for one hour and water quenching. Maximum strengthening of VT9 alloy is produced as a result of decomposition of the martensitic alpha"-phase during aging. The formation of equilibrium alpha- and beta-phases as a result of aging the $beta_M$- and alpha'-phases produces less strengthening although the absolute values of strength are higher. Figures 3.
[55-6368]

NEW HORIZONTAL MULTI-PASS MACHINE FOR THE CONTINUOUS CASTING OF STEEL BLANKS

Moscow IZVESTIYA in Russian 12 Dec 79 p 1

[Article by A. Koptsov: "On the Horizons of Research"]

A new horizontal multi-pass machine for continuous casting of steel blanks has begun operation at the scientific research association "Tulachermet."

Continuous casting allows one to automate the entire process from smelting of steel to rolling, to increase the yield of ready-to-use metal and its quality, and to improve working conditions. That is why the main thrust for growth of the national economy of the USSR for 1976-1980 includes a significant increase in the output of units for continuous casting of steel.

When I approached the unit I was not surprised by its size. Herein lay one of its principal advantages. The Tula innovation does not require high towers or deep pits for its assembly. This machine fits into an ordinary casting shop easily, rising only three meters above the floor. It was manufactured at the request of the Moscow association "AvtoZIL" and has already produced the first industrial lots of small-diameter steel blanks. This makes it possible for automobile manufacturers to produce parts by stamping without having to roll the blanks.

V. Simonov, the head of the "TulaNIIchermet" institute laboratory, says: "This new technique will increase productivity by 26 to 33 percent. On the whole, the economic effect of the horizontal casting machine will result in an annual savings of 2,000,000 rubles.

The machine was developed by a team of the scientific-industrial association "Tulachermet" in cooperation with specialists of the Ukrainian Scientific Research Institute of Metals. It far surpasses all modern units. The horizontal method of casting makes it possible to produce blanks of varying gage and to increase their quality. After rolling round blanks for seamless tubes with a diameter of 130 millimeters at the Rustabskiy Metallurgical and Pervoural'skiy New Tube factories the output of satisfactory metal increased by up to 99 percent. The entire rolled output of reinforced sections produced at the Karagandinskiy and Liyepayskiy metallurgical factories met the GOST standards.

The "Horizontal Unit" has a lot of other advantages over modern units. Its assembled weight is $\frac{1}{1.6}$ -- $\frac{1}{1.8}$ less than for a radial unit, and even less than this for a vertical unit. The low height and compactness allow one to install horizontal machines in shops which are currently operational. The simplicity of design and clever placement of units facilitate operation and repair.

Many metallurgical factories have proceeded with construction of such machines. Foreign firms are also interested in them. From all the evidence it is obvious that the prospects for the horizontal machine for continuous casting of steel blanks are very good.
[65-9424]

9424
CSO: 1842

USSR

UDC: 669.715-153

EXPERIENCE IN THE OPERATION OF A FURNACE WITH AN AIR CUSHION FOR CONTINUOUS ANNEALING OF STRIPS OF ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 79 pp 86-89

TSUKROV, S. L., PASKHIN, L. N., SHCHELBANIN, YU. V., SVETLOV, V. T.

[Abstract] A study is made of the experience of three years' industrial operation of a continuous aluminum strip annealing furnace in which the strips are transported on a cushion of air. The furnace was designed for heat treatment of strips 800-1500 mm wide and 0.8-2.0 mm thick made of non-hardened aluminum alloys. Strip transport conditions and uniformity and intensity of heating and cooling were measured over the course of two years. The operating modes assuring defect-free transportation of the strip on the air cushion were found to be determined by the air pressure in the upper and lower supporting chambers, as well as the tension on the strip in the furnace. Optimal conditions include suspension of the strip 50-70 mm above the nozzle apparatus, with vertical oscillations of the position of the strip not over 20-30 mm. The mean values of heat transfer coefficients are determined by the various sections of the furnace.
[40-6508]

USSR UDC 669.721.5:620.184

EFFECT OF ZIRCONIUM ON THE STRUCTURE AND MECHANICAL PROPERTIES OF MAGNESIUM-BASE HETEROGENEOUS ALLOYS

Moscow IAN SSR, METALLY in Russian No 6, 1979 pp 149-153 manuscript received 3 Jun 77

CHUKHROV, M. V. and KHRISANOVA, Z. I., Moscow

[Abstract] The effect of zirconium on the structure and mechanical properties of the heterogeneous magnesium-base alloys Mg + 4.0% Zn + 1.0% Cd + 1.5% Nd, Mg + 4.0% Y + 4.0% Zn + 0.5% Cd + 1.5% Nd, Mg + 5.0% Y + 4.0% Zn + 1.0% Cd + 1.5% Nd, and Mg + 9.0% Y + 6.0% Zn + 1.0% C + 2.5% Nd was investigated. These alloy compositions were selected with allowance for the attention currently being devoted by researchers to the development of new high-strength alloys based on the Mg + Y system. They were treated with 0.16-0.7% Zr. Treatment with Zr resulted in the suppression of dendritic form of the crystals and the appearance of equiaxial crystals in these alloys. Interacting with the acicular zinc-rich phase of the eutectic, the zirconium alters its form and contributes to a more uniform and compact distribution of that phase among the grains of the solid solution. In addition, zirconium contributes to a more uniform distribution of zinc in the grains of the solid solution. As a result, zirconium, when introduced in amounts of from 0.5 to 0.66%, can enhance the mechanical properties of heterogeneous Mg-base alloys, though it does not enhance the mechanical properties of high alloys of the Mg-Y-Zn-Nd-Cd system (at combined treatment with yttrium and neodymium the solubility of neodymium in magnesium decreases by 35% and the solubility of yttrium, by 14%). Figures 2; references 6: 4 Russian, 2 Western. [70-1386]

USSR

UDC: 669-494:669.7785'5'721

MECHANICAL PROPERTIES OF PLASMA-DEPOSITED ALUMINUM ALLOY IN THE SYSTEM Al-Zn-Mg, USED AS A MATRIX FOR A FIBROUS MATERIAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 116-120, manuscript received 21 Apr 79

ALIPOVA, A. A., IVANOV, V. V., IVANOV, V. G., KUCHKIN, V. V., KHVOSTUNKOV, A. A., Leningrad

[Abstract] A study was made of the mechanical properties and structure of a plasma-deposited material of high-strength thermally hardened Al-Zn-Mg alloy under various modes of gas-static pressing and heat treatment. The influence of the parameters of gas-static pressing on the structure and mechanical properties of the deposited alloy was studied. The strength of the pressed material increased primarily with an increase in temperature and time of pressing, while the relative elongation and Young's modulus remained virtually unchanged. The pressing conditions optimal for the fiber material did not provide maximum strength of the matrix. Matrix strength can be increased by 40% by heat treatment. The combination of vacuum annealing and standard heat treatment can significantly increase the strength and particularly the ductility of the pressed matrix. Figures 2; references 3: 2 Russian, 1 Western.
[64-6508]

UDC 061.6;622.343.5.012.001.2.001.5

ACTIVITIES OF THE MINING ENGINEERS OF THE UNIPROMED' INSTITUTE

Moscow GORNYY ZHURNAL in Russian no 12, Dec 1979 pp 11-14

[Article by V. B. D'yakovskiy, deputy director for mining scientific research operations, V. Ye. Popov, deputy chief engineer, and V. Ya. Firsov, senior engineer]

[Text] Unipromed' is a complex scientific-research and design institute, which conducts projects in the area of mining science, enrichment and metallurgy for the copper, zinc and gold-platinum industries.

The volume operations carried out by the institute is more than 2,500,000 rubles for the scientific section, and 2,100,000 rubles for the design section, which includes 1,000,000 and 1,300,000 rubles respectively for mining subject matter. In the tenth five-year plan alone the mining laboratories have achieved a savings of 70,000,000 rubles by the adoption of their schemes in production and a savings of 40,000,000 rubles by adoption as projects. The institute furnishes 50-60,000,000 rubles' worth of designs annually to mining enterprises.

Since 1976 Unipromed' has been fulfilling the functions of a coordinating organization and it is the main institute for the following problems: controlling underground fires, development of technology for underground extraction with walling up of the worked areas, effective and safe operations in quarries, stability of quarry edges, control of underground detonations and rock pressure, ventilation of deep open pits, bacterial leaching of ferrous and rare metals of their accompanying ores.

The institute, in cooperation with mining enterprises, has developed and introduced new technology, which mades it possible not only to eliminate underground fires, but also to prevent them. For the elimination and prevention of endogenic fires they fill up the worked sections with a clay mud on a scale unknown in the world up to now. On the basis of results of studies done over many years and of experience in controlling fires, the scientists of the institute have developed a methodology for determining the degree of fire hazard of newly proved deposits under laboratory conditions, which permits one to specify the necessary measures for safe working

of deposits at the design stage. The technology for prevention of underground fires which the institute has developed permits the use of highly productive systems (block-induced caving and sublevel caving with increased height of a level). This technology is widely used in many Soviet and foreign mines.

Of great importance are the institute's studies in the area of improving chamber systems using a hardening fill which makes it possible to increase the extraction of ore from the depths, to eliminate the danger of fire, and to significantly increase the yield of minerals. Thus, the Gayskiy Mining and Enrichment Combine has introduced a basically new system of working with continuous extraction of ore and with filling of the worked space by hardening mixtures, which make it possible to work a deposit by the open and underground methods simultaneously (see drawing), to increase the extraction of ore several-fold and to obtain significant savings.

Two directions in working deposits by the underground method should be noted: the improvement of systems which are traditional for copper pyrite deposits of the Urals with caving and preventive filling; the creation and introduction of new versions of systems with hardening fill and the use of self-propelled equipment.

Systems with caving and preventive filling are mainly used in active pits during the opening of lower horizons, and also during working of separate sections in new pits.

In order to improve these systems researchers of the institute solve problems of the rational location of shafts, of the decrease in the yield of off gage ore during its withdrawal, work up designs for connecting the withdrawal ramps, determine the area of application of vibration machines, self-propelled equipment and loading and transport vehicles of Soviet and foreign manufacture, create metallic, portable timbering, which is used beneath a collapse of blasted ore, making it possible to eliminate penetration of withdrawal ramps.

Systems with hardening fill and self-propelled equipment are used in designing new pits. The table gives the relative frequency (%) of engineering systems which are used in working deep horizons of the Gayskiy and Uzel'ginskiy deposits.

Systems of working	Deposit	
	Gayskoye	Uzel'ginskoye
Level-chamber with hardening timbering of chambers [breasts]	48.7	60.0
The same, with filling of secondary chambers by tailings or rock	28.3	17.0

USSR UDC 681.846.73

USE OF FLAME-SPRAYED COATINGS IN THE TAPE DRIVES OF VIDEO TAPE RECORDING EQUIPMENT

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 57 manuscript received 11 Aug 78

KALYUZHNYY, A. D., SHUL'GA, O. V., KARPINOS, D. M. and ZIL'BERBERG, V. G., Institute of Problems of Material Science, Academy of Sciences UKrSSR

[Abstract] The tape drive of videotape recorders must be particularly wear resistant, since it is in friction contact with tape. In this connection, the authors developed the compositions and techniques of application of flame-sparyed coatings to tape-drive spools. Of the compositions tested (chromium, copper, chromium+copper, and bronze), chromium+copper (50+50) proved to be the best. Coatings 0.1-0.3 mm thick were flame-sparyed onto tape-drive components, and it was found that the resulting coefficient of friction between flame-sprayed surfaces was lower (0.28) than in the case of tape drives coated with the normally used Kh18N9T steel. Moreover, jamming of tape is completely precluded, so that the use of flame-sprayed coatings in the tape drives of videotape recorders represents a promising technique. References 5: all Russian
[77-1386]

USSR UDC 669.1'295'781'784.017.1

THE QUASI-TERNARY SYSTEM Fe-TiC-TiB_2

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 60-64 manuscript received 9 Jan 78

SHURIN, A. K. and RAZUMOVA, N. A., Institute of Metal Physics, Academy of Sciences UKrSSR

[Abstract] Alloys of the quaternary system Fe-C-B-Ti were investigated within the concentration range bounded by the Fe, TiC, and TiB_2 phase compositions. Since systems Fe-TiC, Fe-TiB_2, and TiC-TiB_2 are quasi-binary and belong in the eutectic type, it can be assumed that the system Fe-TiC-TiB_2 is quasi-ternary, with a ternary eutectic. It is shown that this quasi-ternary system forms a simple fusibility curve with a ternary eutectic fusing at 1170°C. The structure of the eutectics in the investigated alloys is characterized by the formation of a metal matrix. The hardness of castings of these alloys increases markedly with increase in their concentration of TiC or TiB_2. The hardness of the TiC-TiB_2 eutectic is minimal compared with the noneutectic alloys of that quasi-binary system. Figures 3; references 3: all Russian.
[77-1386]

USSR

UDC 620.18.186.667.764

EFFECT OF STRUCTURAL CHANGES ON CREEP PARAMETERS OF BINARY CARBIDE COMPOSITIONS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 82-88 manuscript received 10 Jan 79

ANDRIYEVSKIY, R. A., SPIVAK, I. I., MITROKHIN, V. A. and KLIMENKO, V. V., Moscow Institute of Fine Chemical Technology

[Abstract] In view of the known existence of high creep (superplasticity) in certain two-phase compositions, the conditions of decomposition within the TiC-ZrC system were investigated for compaction molded specimens annealed at 1850, 1900, and 1950°C for up to 100 hr, as well as for specimens tested for creep during bending and dilatational straining. It is established that the strain rate of the original two-phase TiC-40% ZrC alloy is roughly 1.5 orders of magnitude greater compared with the homogeneous solid solution. It is shown that inhomogeneous alloys in the TiC-VC system display a higher creep rate than do homogeneous alloys. The similarity between activation energies in creep experiments and in experiments with the auto-diffusion of Zr, Ti metal atoms in ZrC, TiC carbides qualitatively points to a diffusion mechanism of creep of the TiC-40% Zr alloy. Figures 4; references 21: 17 Russian, 4 Western.
[77-1386]

USSR

UDC 621.315.61

REACTION-TYPE SINTERING OF BORON NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 52-56 manuscript received 16 Apr 79

RUSANOVA, L. N., GORCHAKOVA, L. I. and ROMASHIN, A. G., Obninsk

[Abstract] Reaction-type sintering (RTS) is a method of activated sintering and it is best applied in cases in which the sintered material lacks diffusion mobility. This is true of compounds with chiefly covalent bonding, of which boron nitride is a typical representative. In this connection, the RTS of a material consisting of turbostratic-structure boron nitride powders and amorphous boron in a nitrogen atmosphere is described. During RTS the compaction of the material is accomplished through the formation of a new boron nitride phase resulting from the chemical reaction between amorphous boron and nitrogen. A formula for the attendant changes in mass and volume

during such nitriding is presented. It is experimentally established that powders with a high oxygen content are the most promising material for RTS, since oxygen and the processes associated with oxidation during RTS are decisive to obtaining high-strength specimens. The mechanism of the RTS of boron nitride is determined by two main reactions: the nitriding of boron and the oxygenation of boron by the oxygen released from the lattice of turbostratic nitride. Figures 4; references 8: 7 Russian, 1 Western.
[77-1386]

USSR UDC 621.724

EFFECT OF POWDER DISPERSITY ON THE SINTERING OF ZIRCONIUM NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 33-39 manuscript received 30 May-79

PSHENICHNAYA, O. V., KUZENKOVA, M. A. and KISLYY, P. S., Institute of Problems of Material Science, Academy of Sciences UkrSSR; Institute of Superhard Materials, Academy of Sciences UkrSSR.

[Abstract] The smaller the particle size the more active the process of the sintering of powder becomes. However, relatively few studies have been made of the dependence between the dispersity of the powder and the possible mechanisms of sintering. To fill this gap, the effect of dispersity on the sintering kinetics and grain recrystallization was investigated in billets compacted from classified monodisperse powders of zirconium nitride (fractions $\leq$3; 5-7; 14-20; and 40-60 um). Powders of each fraction were compacted into cylindrical specimens measuring 8 mm in diameter and 16 mm in length. The specimens were then vacuum-sintered and curves of their sintering kinetics were plotted. The shrinkage of specimens of the $\leq$3 um fraction reached 98% within the first 5 min and their porosity decreased to 3-5%; in comparison the figures for the larger fractions were much worse and the specimens of the largest fractions (20-20 and 40-60 um) underwent virtually no sintering at 1800-2000°C and their porosity was almost unchanged. The size of recrystallized grains in the sintered ZrN specimens was larger for specimens of the finely dispersed fraction ($\leq$3 um). This is apparently due to the coalescence of the fine particles owing to their sliding and rotation relative to each other upon the disappearance of their boundaries during sintering. Figures 5; references 9: 6 Russian, 3 Western.
[77-1386]

UDC 621.762

USSR

HOT PRESSING AND VACUUM SINTERING OF HIGHLY DISPERSED TITANIUM NITRIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 27-32 manuscript received 13 Feb 79

TORBOV, V. I., TROITSKIY, V. N., and RAKHMATULLINA, A. Z., Institute of New Chemical Problems, Academy of Sciences USSR

[Abstract] The sinterability of highly dispersed TiN (particle size 0.5 um) was investigated for billets obtained by hot pressing and vacuum sintering TiN powders. With increase in the unit surface area (dispersity) of TiN to 90 from 18 m^2/g the onset temperature of recrystallization of freely poured powder was found to decrease to 600 from 1300°K. The temperature of onset of virtually 100% density billets of hot-pressed TiN (particle size of the powder 0.05-00.7 um) was 1600°K, which is 500-700°K lower than the temperatures required for complete sintering of coarse-grained powders (particle size about 0.5 um). At hot pressing temperatures exceeding 1800°K the density of the sintered briquets began to decrease, apparently owing to the onset of release of nitrogen by the nitride and the formation of microcracks. The grain size of both hot-pressed and sintered specimens is roughly the same, and for sintered specimens it chiefly depends on the temperature and duration of the sintering. Figures 4; references 14: 13 Russian, 1 Western.
[77-1386]

UDC 621.762.2

USSR

INVESTIGATION OF THE STRUCTURE OF THE SURFACE AND INTERIOR FORMATION OF TITANIUM ALLOY GRANULES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, 1979 pp 1-7 manuscript received 31 May 78

LOKSHIN, YE. deceased, L., BOCHVAR, G. A., BORZETSOVSKAYA, K. M., KAPUTKIN, YE. YA. and BOLOTINA, T. I., Moscow

[Abstract] The structure of the surface and internal layers of Ti alloy granules and its effect on the formation of poreless material was investigated on specimens of one of the most common Ti alloys, VT3-1. A special feature of these granules, ranging in size from 50 to 900 um, is the transition from dendritic to acicular structure and the appearance of the oc" phase with decrease in granule size. The state of the surface of the granules is characterized by the presence of 100-2000 Å thick films of

lower titanium oxides: Ti_2O_3, Ti_2O_5, Ti_4O_7. The thickness of these films increases with annealing temperature. High-temperature vacuum annealing at 900°C causes these films to dissolve. A qualitative consolidation of the granules with film thickness ~350 Å is observed at temperatures of 900°C and higher. The presence of 350 Å thick oxide film on the granule surfaces adversely affects the quality of the compact blanks pressed from the granules. Cyclic heating in the transition temperature range can enhance the plasticity of such blanks. Figures 3; references 4: all Russian. [77-1386]

UDC: 669-494:536.4

USSR

THERMAL STABILITY OF THIN FILMS ON REINFORCED FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 125-128, manuscript received 21 Apr 79

GOL'DINER, M. G., MAZUR, V. A., Kishinev

[Abstract] Earlier experiments have indicated that there is a precise value of interphase energy above which the polycrystalline precipitate breaks down, while below which it is converted to an epitaxial film around the reinforcing fibers in composites. Other experiments have indicated that the thin film surrounding a fiber differs from a plane film in that uncompensated edge dislocations are located along the axis of the film, decreasing the morphologic stability of single crystal films of this type. These propositions were experimentally tested using nickel and aluminum films applied to carbon fibers about 6 um in diameter and plates of vitreous carbon, as well as copper plates applied to polycrystalline molybdenum and tungsten wire 50 um in diameter, polycrystals and various single crystals of molybdenum and tungsten. It was affirmed that the influence of substrate geometry on film breakdown is a threshold effect appearing when the elastic energy reaches a value on the order of the interphase energy. The behavior of a polycrystalline film during annealing is thus determined by two competing processes: breakdown of the continuous film and formation of the epitaxial film. Figures 2; references 4: all Russian. [64-6508]

USSR UDC 620.186:620.17:669.295'71'28'292'1'3'296'6

INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF A TITANIUM ALLOY IN THE Ti-Al-Mo-V-Fe-Cu-Zr-Sn SYSTEM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 59-61

MOISEYEV, V. N., DOLZHANSKIY, YU. M., ZAKHAROV, YU. N. and ZNAMENSKAYA, YE. V.

[Abstract] VTi4 titanium alloy was additionally alloyed with Sn, Zr, Cu and Fe. Mechanical tests were performed on samples of this alloy where it was found that strength increases with increased content of Sn, Zr, Cu, and Fe within the limits specified. The most effective strengtheners were Sn and Cu. After heat treating at 850°C for two hours followed by air cooling plus heating to 550° for six hours and air cooling the tensile strength of semifinished products, produced by deformation in the beta-region, amounts to more than 120 kgf/mm^2 with satisfactory ductility and operational reliability. This alloy is best suited to be used at 400-500°C. Figures 4.
[55-6368]

USSR UDC 669.27:620.17:669.295'71'296

EFFECT OF TUNGSTEN ON THE MECHANICAL PROPERTIES OF A Ti-9% Al-3% Zr ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 58-59

NARTOVA, T. T., GRIGOR'YEV, I. P., STEPANOV, YU. N., and TARASOVA, O. B., Institute of Metallurgy imeni A. A. BAYKOV and the Chubashkiy Pedagogical Institute imeni I. YA. Yakovlev

[Abstract] Samples of a Ti-9% Al-3% Zr alloy were additionally alloyed with 0-10% W and tested in the forged (non-heat treated state) and heat treated state. Heat treatment consisted of a one-hour anneal at 900°C followed by a vacuum step anneal of 900° for 20 hours + 800° for 100 hours + 600°C for 100 hours and air cooling. Samples that were not heat treated as well as those that were underwent brittle fracture during tensile tests at 20°. At 600° the alloy samples possessed satisfactory ductility which was lost if the tungsten content was greater than roughly one percent. A tungsten content was greater than roughly one percent. A tungsten content of about 0.7% was found to be optimum providing small maximums of hardness and strength as long as the operating temperature was around 600°. Figures 1; references 5: all Russian.
[55-6368]

UDC: 621.791.357:669.295

USSR

CONTACT-REACTIVE SOLDERING OF TITANIUM ALLOYS THROUGH AN INTERMEDIATE LAYER OF PALLADIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 79, pp 17-18

BESEDNYY, V. A., (deceased) KANDYBA, YE. F., Engineers, All-Union Scientific Research Institute of Compressor Machine Building

[Abstract] A study is presented of the properties of joints in titanium alloys produced by contact-reactive soldering through an intermediate layer of palladium. Studies were performed on specimens of VT6S, VT14, VT3-1, VT5-1 and AT6 alloys. Plates measuring 12 X 12 X 100 mm were used to assemble specimens for metallographic studies. The active metal used was a palladium foil 99.9% pure. Soldering was performed in a vacuum furnace at 1160°C at a pressure of $1 \cdot 10^{-4}$ mm Hg followed by diffusion annealing at 960°C for 8 hours. The process improved the mechanical properties of the solder joints. Photographs illustrate the microstructure of the metal of the joints after soldering and after annealing. Figures 2; references 6: all Russian.
[46-6508]

UDC 620.17:620.18:669.295.5

USSR

POSSIBILITIES OF INCREASING THE MECHANICAL PROPERTIES OF TITANIUM ALLOYS BY STRUCTURE OPTIMIZATION

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 51-55

BRUN, M. YA., All-Union Institute of Light Alloys

[Abstract] Titanium alloys with a globular structure possess a certain set of mechanical properties while those with a lamellar structure possess a different set of properties almost completely opposite. By specific heat treatments it is possible to produce a mixed globular-lamellar structure which will possess the best set of properties from each of the structures. The mixed structure can be produced by heat treating at a temperature 15-30° below the polymorphic transformation temperature. Proper heat treatment of coarse grain alloys can produce a more optimum structure, depending on the mechanical properties being sought. Figures 5; references 3: all Russian.
[55-6368]

USSR UDC 620.193.4

THE EFFECT OF PURITY AND PRESSURE OF HYDROGEN ON THE GAS SATURATION OF TITANIUM ALLOYS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15, No 6, Nov-Dec 79 pp 111-113 manuscript received 4 Jan 77

SUKHOTIN, A.M., ANTONOVSKAYA, E.I., SGIBNEV, YE.V. and SHUL'MAN, A.F., State Institute of Applied Chemistry, Leningrad

[Abstract] An experimental study was made to determine the dependence of the hydrogen saturation in VT1, OT4 and AT2 titanium alloys on the oxygen concentration and the pressure as well as on the length of treatment. Annealed specimens of these alloys were saturated first with pure hydrogen under a pressure of 10^3 Pa and then, while oxygen was added in amounts ranging from 10^{-6} to $1.6 \cdot 10^{-2}$ (commercial) vol.%, the rate of hydrogenation was measured at various pressures and temperatures over a period of 48 hours. Under 10^5 Pa at 500°C, typically, the mass concentration of saturating hydrogen was found to drop very fast with increasing volume concentration of oxygen. The isotherms indicate that the hydrogenation rate is highest in the case of pure gas and decreases with increasing oxygen concentration. Correspondingly, the temperature at which cracking will occur after a certain period of time becomes lower with increasing oxygen concentration. The temperature of catastrophic fracture on the other hand, while depending on the length of treatment, becomes higher with increasing oxygen concentration. This trend is attributable to "self-curing" by a protective oxide film. The isobars for almost pure hydrogen indicate that only the maximum hydrogen saturation level increases with increasing pressure, inasmuch as the alloying elements here do not form hydrides. Figures 4; references 5: all Russian.
[61-2415]

USSR

UDC 669.295.5:539.43:620.194.8

FEATURES OF FATIGUE FRACTURE OF TITANIUM AND ITS ALLOYS IN AN NaCl SOLUTION

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 15, No 6, Nov-Dec 79 pp 86-88 manuscript received 28 Feb 77

POKHMURSKIY, V.I., YAREMCHENKO, N. YA., KALAKHAN, O.S. and PRISHLYAK, A.M., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] A metallographic and fractographic study was made to determine the effect of a corrosive medium such as an aqueous NaCl solution on the fatigue fracture of various titanium alloys. Metallographic specimens of VT1 (α), VT5 (α), AT3 (α'), PT3V (α') and VT14 (α+B) alloys were tested under stresses of (1.05-1.10)σ- and 1.30σ-. While fracture in 3% NaCl was found to be more brittle than in air, to an extent depending on the alloy composition, this corrosive medium was found to lower the endurance limit of the α+B alloy, to raise the endurance limit of the α' alloys, and in the case of the α alloys to either lower or raise it. Figures 2; references 7: 6 Russian, 1 Western.
[61-2415]

USSR

UDC: 669.295

CONCERNING THE INFLUENCE OF RELATIVE HUMIDITY OF THE AIR ON THE QUALITY OF SPONGE TITANIUM

Moscow TSVETNYYE METALLY in Russian No 10, Oct 79 pp. 56-57

CHEREPANOVA, YE. A., NIKITINA, T. I., GULYAKIN, A. I., YATSENKO. A. P.

[Abstract] A study was made of the variation in quality of sponge titanium as a function of the relative humidity of the air in which the titanium sponge is treated. This was achieved by analysis of statistical data from a titanium-magnesium enterprise covering the period 1973-1977. Weighted-mean quality indices were calculated, temperature and relative humidity of the air in the titanium sponge processing areas were systematically measured, and information from the city weather station was also used. Correlation analysis showed that the hardness and oxygen content of the titanium sponge depends significantly on the absolute moisture content of the atmosphere, as well as the difference in the temperatures between the air outside and the air temperature within the titanium sponge processing room. This is particularly clearly seen in summer. No variation was found in content of chlorine, nitrogen or iron in the titanium sponge as a function of the factors measured. Figure 1; references 11: all Russian.
[40-6508]

USSR UDC 669.295

MOISTURE ABSORPTION BY TITANIUM SPONGE DURING ITS REPROCESSING INTO A COMMERCIAL PRODUCT

Moscow TSVETNYYE METALLY in Russian No 11, Nov 79 pp 74-76

ALEKSANDROVSKIY, S.V., CHEREPANOVA, YE.A., VOROTINOVA, B.G., POPOVA, S.V. and GULYAKIN, A.I.

[Abstract] For a more accurate control of titanium sponge reprocessing, its interaction with moisture during drying, casting and subsequent operations as well as during storage in air was evaluated with the stable isotopic tracer ^{18}O (heavy oxygen) in water. Bloom and furnace specimens were tested for moisture content over a period of 8-24 hours with the temperature cycled from 20 to 75°C and to 125°C. Adsorption and capillary condensation of moisture were found to increase with higher temperature above ambient, with higher ambient humidity and with longer exposure. Comminution of the sponge also results in more moisture adsorption. Reprocessing under optimum possible hygrothermal conditions will soften commercial titanium sponge in summer and reduce seasonal fluctuations of the metal quality indicators. References 5: 4 Russian, 1 Western.
[73-2415]

USSR UDC: 621.791.753.9:669.295

STABILITY OF TUNGSTEN ELECTRODES IN ARGON-ARC WELDING OF TITANIUM UNDER FLUX

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 79 pp 41-43, manuscript received 22 May 78

PRILUTSKIY, V. P., Engineer, IVAŃOVA, O. N., MECHEV, V. S., ZAMKOV, V. N., Candidates of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] An estimate is presented of the change in the shape of the end of the tungsten electrode as a function of the composition of the alloying additives, angle of turning of the electrode and length of the arc. A study was performed while surfacing VT1-0 titanium plates with electrodes consisting of tungsten rods 4 mm in diameter containing up to 1.5% of one of the oxides: Al_2O_3, Nd_2O_3, Dy_2O_3, La_2O_3, CeO_2, ThO_2, Y_2O_3, or Ti_2O_3. Turning angles were 30, 45, 60 and 90°. The influence of blunting was evaluated on the electrodes of all of the compositions studied with a turning angle of 45° and a blunting diameter of 0.5 mm. The electrode with Y_2O_3 was found to be superior for welding of titanium under flux. Figures 5; references 8: 5 Russian, 3 Western.
[44-6508]

USSR UDC: 621.791.011

WELDABILITY OF M40 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 79 pp 52-54, manuscript received 24 Oct 77; after revision 1 Mar 78

ISHCHENKO, A. YA., IGNAT'YEV, V. G., Candidates of Technical Sciences, CHAYUN, A. G., Engineer, Kiev, and ZAYTSEV, V. I., SKOROSPELOV, V. V., DRUZHININ, A. T., Engineers, Moscow

[Abstract] A study was made of the possibility of improving the weldability and increasing the strength of joints welded in M40 alloy by the use of improved methods of arc welding using tungsten electrodes and new additives. It was found that the danger of formation of hot cracks in the welded seam can be greatly reduced by the use of wire made of 01177 or 1201 alloy. Helium-arc welding with forward-polarity dc and plasma-arc welding with reverse-polarity dc, which have lower values of energy per unit length of seam, produced stronger seams. References 4: all Russian.
[44-6508]

USSR UDC: 621.791:62-419-478

SPECIFICS OF WELDING OF HONEYCOMB PANELS ON SPECIALIZED MACHINES

Moscow SVAROCHNOYE PROIZVODSTVE in Russian No 8, Aug 79 pp 13-15

GANIN, YU. K., SHORNIKOV, V. M., YANCHUK. L. M., Engineers

[Abstract] A description is presented of the processes involved in assembly and welding of honeycomb panels. Diagrams of the machines used are presented, plus a photograph of the microstructure of the metal at a spot weld. The honeycomb panels are assembled of strips of honeycomb filler which are welded both to each other and to the solid metal strips which form the sides of each honeycomb panel. Figures 5.
[45-6508]

USSR UDC: 621.791.72.01:620.192.4:669.14.018.8

SELECTION OF ENERGY PARAMETERS OF ELECTRON-BEAM WELDING IN ORDER TO REDUCE THE FORMATION OF HOT CRACKS NEAR THE SEAMS IN HEAT RESISTANT ALLOYS

Moscow SVAROCHNOYE PROIZVODSTVE in Russian No 8, Aug 79 pp. 3-6

MOROCHKO, V. P., Engineer, YAKUSHIN, B. F., Candidate of Technical Sciences, VERIGIN, A. M., Engineer

[Abstract] A study was made to determine the variation in strength in the zone around the welded seam of heat resistant metal welded by electron-beam welding methods as a function of the electron beam welding mode. The experiments were performed on type E1698 dispersion-hardened metal alloy with total content of aluminum and titanium of 3.61 and 3.96%, as well as type EP742 alloy with a total aluminum plus titanium content of 5.5%. The studies showed that the hot crack formation tendency is directly proportional to the heat content of the volume of melted metal in the welded bath per second. The best results were achieved by reducing this heat content by decreasing the welding speed. An alternate method is to decrease the area of melting. Another method such as angling the beam at 45° to the axis of the seam, increasing accelerator voltage, use of sharp focusing of the beam, optimal finishing of edges to be welded or alloying of the seam with pure molybdenum, vanadium or iron can also reduce the heat content of the bath volume per second. Figures 7; references 11: 7 Russian, 4 Western.
[45-6508]

USSR UDC: 621.791.753.9.019.001.2:669.71

INFLUENCE OF MOISTURE CONTENT OF PROTECTIVE GASES ON THE FORMATION OF PORES UPON WELDING OF ALUMINUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 79 pp 8-9, 26, manuscript received 17 May 78; after revision 13 Oct 78

PSARAS, G. G., Candidate of Technical Sciences ("Zhdanovtyazhmash" Production Union)

[Abstract] Results are presented from a study of the influence of the addition of dry hydrogen, as well as water vapor, to the argon used to weld aluminum with a fusible electrode on the formation of pours during welding. The test welds were made by surfacing plates of ADI alloy with SvA5 welding wire 2.5 mm in diameter with a welding current of 380-420 A, voltage 34-36 V, speed 12-14 m/hr, and protective gas flow rate 28-30 e/min. Before it was mixed with the argon, the hydrogen was passed through a solution of $K_2Cr_2O_7$, in concentrated sulfuric acid and through phosphorus pentoxide to remove moisture and other impurities. It was found that when the hydrogen content was increased to 15%, the same number of pores were formed as when no hydrogen was added to the argon. The argon was then moistened by passing it through a flask containing water. The results of the experiments are presented in the form of a mathematical model consisting of regression equations describing the interrelationship of the number of pores with the factor studied, namely: relative humidity of air around the arc, dew point of the protective gas and time of existence of the welding bath. Water vapor was found to cause intensive formation of pores in the seam metal. Figures 2; references 5: 3 Russian, 2 Western. [44-6508]

USSR UDC: 621.791:669.620.192.47

BEHAVIOR OF DISSOLVED HYDROGEN IN THE PROCESS OF FRACTURE OF WELDED JOINTS IN HIGH-STRENGTH 01963 ALUMINUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 79 pp 8-9

SUKHOVERKHOV, A. A., TALAYEV, V. S., engineers, DANILKIN, V. A., Candidate of Technical Sciences

[Abstract] A study was made of the behavior of dissolved diffusion-mobile hydrogen during heating of welded joints. The specimens were welded in one pass by argon-arc, plasma-arc and electron-beam methods in 01963 aluminum alloy plates 4 mm thick in modes designed to provide the maximum ductility. The experiments showed that the redistribution of dissolved hydrogen depends

on the ductility of the welded joint. The presence of a soft relaxing interlayer facilitates complete elimination of hydrogen segregations in the process of welding. Figures 1; references 12: 9 Russian, 3 Western. [63-6508]

USSR UDC: 621.791.052.001.5:621.3.038.8

PROPERTIES OF WELDED JOINTS MADE WITH A HIGH POWER LASER BEAM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 79 pp 13-15

SHMELEVA, I. A., GANTMAN, S. G., PAVLOVICH, A. A., SOKOLOVA, L. I., KOSYREV, F. K., MORYASHCHEV, S. F., FROMM, V. A., engineers

[Abstract] The purpose of this work was to establish the possibility of using a continuous powerful CO_2 laser beam to weld steel by through melting in various spatial positions. Welding was performed on plates of low-alloy steels, the chemical composition and mechanical properties of which are presented in tables. The plates were brought together with no gap and the edges were unfinished. No welding wire was used and the welding bath was protected by inert gas only on the beam input side. A two-mirror cassegrain lens system focussed the beam to 10° convergence. Plates 8-15 mm thick were welded with a beam power of 20 kw at 90 m/hr. Photomicrographs of the structure of welded seams and metal in the heated area are presented. Satisfactory mechanical characteristics were achieved, but some specimens had individual defects, particularly micropores or pores up to 0.1-0.2 mm in diameter. Figures 3; references 3: 2 Russian, 1 Western. [63-6508]

USSR UDC: 621.791.01:536.2:620.178.3

THERMAL FATIGUE AND ENDURANCE OF WELDED JOINTS IN CHROME-NICKEL HEAT-RESISTANT ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 79 pp 6-8

PRONINA, YE. M., Candidate of Technical Sciences, MASLOVA, N. D., FEDOROVA, G. V., engineers

[Abstract] A study was made of the effect of the following factors on the thermal fatigue and endurance of welded joints: initial structure of the base metal before welding; heat treatment before and after weldings; deformation during rolling of seams and preliminary drawing of specimens before

welding, imitating shape change as encountered in sheet parts; stress concentrators in the form of seams or scratches. The studies were performed on the KhN56VMTYu and Kh15M30VMT alloys, hardened by dispersion hardening. The properties of the welded joints were found to depend on heat treatment after welding: with proper heat treatment the joint metal and base metal had equal strength. If the initial structure of the base metal had large grains or if the seams were not properly smoothed and rolled, thermal fatigue and endurance of KhN56VMTYu alloy were reduced. Figures 4; references 5: all Russian.
[63-6508]

USSR UDC: 621.791.053:620.18:669.715

STRUCTURE AND PROPERTIES OF WELDED SEAMS OF ALUMINUM ALLOYS AS A FUNCTION OF CERTAIN WELDING TECHNOLOGY FACTORS

Moscow SVAROCHNOYE PROIZVODSTVE in Russian No 8, Aug 79 pp 28-29

SITYAVIN, YU. I., Engineer, TERMINASOV, YU. S.,(deceased) Doctor of Physical and Mathematical Sciences, and ZUBRIYENKO, G. L., Candidate of Technical Sciences

[Abstract] A study is presented of the relationship between parameters of the structure and properties of the metal of welded seams and technological factors which determine the amount of heat liberated. This study was performed on AMg6 and 1201 alloys 4 mm thick, welded by three methods: argon arc continuous welding; argon arc welding with electromagnetic movement; and argon arc welding with periodic feed of the welding wire. Decreasing the energy liberated decreases grain size in the structure and improves strength property. Figures 6; references 6: all Russian.
[45-6508]

USSR UDC: 621.791.4.001.5:539.378.3:620.179.16:669.295

STUDY OF THE POSSIBILITIES OF THE ULTRASONIC METHOD OF TESTING OF TITANIUM ALLOY JOINTS PRODUCED BY SOLID-PHASE WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 9, Sep 79 pp 30-32

AZAROV, N. T., MATYUSHKIN, B. A., LEVTOVA, K. A., Candidates of Technical Sciences, ARIYEVICH, G. E., ZAYTSEVA, L. D., Engineers

[Abstract] Defects in solid-phase welding (diffusion bonding) joints are classified in three groups according to the cross-sectional area and opening of the defect. The ability of ultrasonic testing methods to locate the two most dangerous types of defects was tested, and it was found that type DUK-66P series-produced ultrasonic apparatus can reliably find defects with areas of over 0.2 mm^2 and openings over 1 um in specimens 8-15 mm thick. Specimens 1.5-5 mm thick can be tested by ultrasonic equipment under water. Figures 6; references 2: 1 Russian, 1 Western.
[46-6508]

USSR UDC 621.791.4:539.378.3

PHYSICO-MECHANICAL PROPERTIES OF DIFFUSION-WELDED JOINTS BETWEEN THE VZhL12U ALLOY AND E1961 STEEL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 79 pp 46-49 manuscript received 6 Dec 78

BORDAKOV, P. A., engineer, SAMORODOV, D.V., engineer, GRISHIN, I.S., engineer and PROKHOROV, A. A., engineer, Kuybyshev Institute of Aviation imeni S.P. Korolev

[Abstract] Turbine wheels made of the heat-resistant VZhL12U ca[illegible] nickel alloy and shafts made of E1961 steel were joined by diffusion welding under vacuum. In order to produce joints of adequate mechanical strength close to that of the VZhL12U alloy, it was found necessary to add a 50-um-thick interlayer of technical-grade nickel. Subsequent metallographic examination of specimens after welding and mechanical tests at room temperature as well as at a typical service temperature of 500°C, according to a mathematically planned experiment, yielded data on static and fatigue strength of such joints as well as on the microstructure and the hardness profile of the transition zone. Annealing for several hours at temperatures from 110 to 1150°C under vacuum neither lowers the strength of such a joint nor reduces the barrier effect of the interlayer. This method of welding is, therefore, suitable for these materials. Figures 5; references 4: all Russian.
[72-2415]

USSR

UDC 621.791.793

ON THE POSSIBILITY OF HARD FACING STEEL WITH TITANIUM NITRIDE

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 79 pp 71-72

SVETLOPOLYANSKIY, V. I., Candidate of Technical Sciences, DAN'KIN, A.A., Candidate of Technical Sciences, and ORESHKIN, V. D., Doctor of Technical Sciences

[Abstract] Titanium nitride is a refractory material with excellent mechanical characteristics such as hardness, heat and wear resistance, and chemical stability in acidic and alkaline solutions at high temperatures. It is not used for facing steel, however, because of its low thermal and electrical conductivity as well as poor wettability. A technological process making this possible has been developed at the Volgograd Institute of Construction Engineering. It is an electroslag welding process (I= 300-350 A at 20-30 V) with an electrode of refractory tungsten and with a special flux (AN20+ An349-A= 1:1). The first face layer is deposited with the current in the forward direction and, after trimming, the second layer is deposited with the current polarity reversed. The result is a nonporous nondefective face layer containing primary titanium nitride and eutectic solid solutions. The hardness and the wear rate of experimental steel (St 3) specimens were found to smoothly increase and decrease, respectively, with increasing TiN content in the slag mixture. Academician G.V. SAMSONOV (deceased), corresponding Member of the Academy of Sciences of the Ukrainian SSR, served as science consultant. Figures 3; references 1 Russian.
[72-2415]

USSR

UDC 621.791.052.08:669.295

WELDING OF THE AT3 ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 79 p 76

BLASHCHUK, V. YE., engineer, FERBUNATOVA, A.N., engineer, and SHELENKOV, G.M., Candidate of Technical Sciences

[Abstract] The mechanical strength of the low-cost AT3 titanium alloy, containing an o -phase stabilizer (aluminum) and B-phase stabilizers (chromium, iron and silicon) but no scarce elements, is at 200°C twice as high as that of the VT1-0 alloy. It is being used increasingly for chemical industrial equipment. Rolled strip 8-35 mm thick was tested for weldability, in terms of tensile strength (GOST 6996-66) and impact strength (GOST 9454-60) in the seam and in the zone of thermal influence, at temperatures from 20 to 300°C. The joints were made with an argon arc and a tungsten electrode, with and without electromagnetic stirring. The welding was done automatically without separation of the edges and manually either with an X-form separation of edges or with a slit clearance between them. The results of measurements were found to be distributed normally. References 3 Russian.
[72-2415]

METALS FROM THE OCEAN

Tallin SOVETSKAYA ESTONIYA in Russian No 266, 22 Nov 79 p 3

[Article by B. Rozen, Senior Associate in the USSR Academy of Sciences: "Metallurgy of Neptune"]

[Text] On an express train from Moscow to Simferopol' an argument broke out between members of a scientific expedition being sent to the Crimea. The subject of the dispute was of obvious interest to them: how to correctly explain what seawater is.

First to speak was a geographer: "I would say it's the water that covers three-fourths (70.6 percent, to be precise) of the earth's surface."

"I would add," said a meteorologist, "that it is the primary heat-carrier of our planet's 'central heating system'. As we know, dry land heats up and cools down quickly. Seawater, on the other hand, cools down slowly. One cubic meter of seawater cooled five degrees heats upwards of 3,000 cubic meters of air."

"From my point of view," remarks a physician, "seawater is an excellent antibiotic. It kills staphylococci against which even penicillin is not effective. In fact, even doctors in ancient Greece and Rome, India and China placed high value on the curative power of seawater. Thousands of years ago, it was invariably recommended that patients bathe in seawater."

"And we think seawater is liquid ore," adds a metallurgist.

Upwards of 70 chemical elements have been found in sea and ocean water. Along with the metals in which the earth's crust is rich -- iron, copper, manganese, it contains salts of such rare metals as cesium, lithium and rubidium. There is also gold, uranium and radium.

Although the concentrations of a majority of the metals in seawater are infinitesimally small -- only hundredths or thousandths of a milligram per liter (0.12 for lithium and 0.0005 for cesium, for example) -- they are of commercial interest.

Seawater also contains metals in rather higher concentrations, including potassium and magnesium. Thus, one cubic meter of seawater contains 1,300 grams of magnesium.

Early in our century, only photographers and pyrotechnicians used magnesium. But even before World War I it was noted that metallic alloys of magnesium and other metals were lighter than steel and iron and were their equal in strength. Various automobile, airplane and helicopter parts are manufactured out of magnesium alloyed with lithium, beryllium and cobalt. Lithium-magnesium alloys have recommended themselves especially well. They are the lightest and most heat-resistant alloys. Such alloys are used in the manufacture of rockets and in building supersonic aircraft and space ships.

Heretofore, the main source of magnesium and its compounds has been such minerals as magnesite, carnallite and dolomite. However, seawater is increasingly more competitive with them with each passing year. In fact, the magnesium reserves in the world ocean are practically inexhaustible, about 2,200,000 billion tons.

The technology for extracting magnesium from seawater is very simple. Powerful pumps pump seawater to filters or it is brought to artificial basins by canal. Here, the water is continuously processed by milk of lime produced from sea lime obtained by roasting oyster shells.

The lime interacts with magnesium salts dissolved in the seawater. A thin magnesium oxide hydrate suspension forms and goes to a settling tank. Water is drawn out and the precipitate is dried on filters; it is neutralized by a chloride, concentrated in an evaporator, and finally dehydrated in driers. The magnesium chloride formed by interacting with the chloride undergoes electrolysis. The current breaks up the magnesium salt molecules and a layer of magnesium is deposited on the cathode. Metal billets weighing 7-8 kg are cast out of it.

Magnesium was first obtained from seawater in England in 1916. Eight years later, it was being extracted from the Dead Sea in Palestine. Now, there are already several dozen plants in the world extracting magnesium and magnesium compounds from seawater.

Upwards of 20 plants are in operation in the USA and Britain alone and meet all these countries' magnesium requirements. This valuable metal is also being extracted from seawater in other maritime countries -- Italy, France, Tunisia.

Currently, upwards of 40 percent of world magnesium production (excluding the USSR) comes from the sea.

In our country, the shallow Sivashskiy Bay in the Sea of Azov will soon become a major supplier of magnesium. Some 3.5-fold more magnesium oxide (and consequently metal as well) can be extracted per cubic meter of water here than from seawater in other places. Sivashskiy Bay salts are 16-17 percent magnesium salts.

Plans have already been drawn up for a magnesium plant to be part of a chemical combine which will be built in Sivash in the immediate future.

Another source of magnesium from seawater will in time be located on the Mangyshlak Peninsula. It has a large depression just 12 km from the shoreline which drops 100 meters below the level of the Caspian Sea. If a canal were to be dug in this depression and the water from the Caspian let into it, a sort of lake would gradually be formed in it; various salts, including those of magnesium, would accumulate on the bottom.

And so, maritime metallurgy is gathering strength a bit.

Back 35 years ago, the Japanese developed methods of extracting rare and valuable metals -- lithium, rubidium and cesium -- from salt sources (remaining after the sodium chloride was removed from salt basins). They are now being used widely in new equipment: automatics, television, rocketry and other fields. These metals are encountered rarely in the earth's crust, and are usually associated with other metals at that. Such ores must therefore be enriched, which is very expensive. But it is quite a bit cheaper to extract these metals from seawater.

The extraction of gold from seawater is of great interest. Specialists estimate that the seas and oceans contain about 10 million tons of gold (nearly 300 times as much as is in the earth's crust). However, it is not all that easy to extract it. In fact, one cubic meter of water contains only 0.00001 gram of gold. Scientists and inventors have been seeking profitable methods of extracting gold from seawater for more than 100 years now, but no such method has yet been found.

Approximately 20 years ago a Soviet chemist, A. V. Davankov, succeeded in extracting several grains of gold from seawater. He installed several large glass open-ended cylinders on the deck of the "Mikhail Lomonosov" expeditionary ship. Ionite (ion-exchange resin) granules were poured into them and the seawater passed through them. These marvelous plastic granules are able to selectively absorb various chemical elements and substances.

Davankov's catch was small, only one milligram of gold from 500 cubic meters of water, but it opened a new page in maritime gold-mining industry. There will come a time when commercial ships supplied with absorption columns will bring in gold and various rare metals when returning from a voyage.
[59-11052]

11052
CSO: 1842

METAL FOR THE NEW TECHNOLOGY

Moscow IZVESTIYA in Russian No 302 27 December 1979 p 2

/Article by President of the Ukrainian Academy of Sciences, Academician B. Paton: "Metal for the New Technology: Speeding Up the Introduction of Scientific-Technical Designs and Discoveries Into Production"/

/Text/ There is a precise quantitative indicator of how efficiently the system "science - technology - production" is functioning. This indicator is the time in which production is able to assimilate the achievements of fundamental and applied research. Today it is years rather than decades that separate many fundamental discoveries from their assimilation by industry. For example, from the time that a radio or electronic tube was discovered until it was assimilated more than 30 years had passed, but from the creation until the practical realization of solar batteries and lasers less than three years elapsed.

This is a regular and necessary tendency to reduce the time periods for assimilation. With the high dynamism of modern production forces the period of obsolescence of new equipment and technology does not exceed six to eight years. This is why it is now important to find and create forms of the tie between science and production that will substantially reduce the span of time between the birth of an idea and its practical application.

In the Ukrainian Academy of Sciences much attention is devoted to questions of the speeded-up utilization of the results of scientific research in the building of communism and to the search for new and the improvement of existing forms of the tie with production. The efforts of the scientific collectives of the republic are aimed at the further intensification and expansion of fundamental and applied research, at the creation on this basis of basically new technologies and at the rapid transfer of these new technologies to the national economy. During the past five-year period they created more than 300 new technologies of varied level and scope, which are being successfully used in the enterprises of ferrous metallurgy, chemical, ship building, aviation, gas, food and several other branches of industry. Recognition of the high quality of the technologies created in the Ukrainian Academy of Sciences is the sale of 42 licenses for them to industrially developed nations. We are proud that the Central Committee of

the CPSU has approved this year the experience of the Ukrainian Academy of Sciences in creating new technologies on the basis of fundamental research and has outlined specific ways to develop and broadly disseminate the experience.

How is the system "science - technology - production" functioning in the republic? First of all we are constantly concerned about intensifying fundamental research. They are working for the future and are not governed rigidly by the requirements of the present. The success of this sector determines both the raising of production to a qualitatively new level and the successful advancement of the very front of science.

The following stage is also extremely important - the organization on the basis of fundamental research of applied and technological designs. Their purpose is to find the shortest and most rational ways and means to use in practice those laws of the objective world, which are acquainted with the fundamental sciences. In this link the foundation is laid and the general contours of the technology of the future are determined. It is here that information, which proceeds both from the fundamental sciences and production, is refined and reunited.

Institutes engaged in natural and technical sciences are directed toward the development of fundamental research and the creation on their basis of the latest technologies. When distributing money allocated for science, we seek to accomplish a program of financing that will to the greatest extent favor the development of progressive technologies. Funds from involved ministries and departments also come into play here. This speeds up the process of creation and, most important, the adoption of innovations and promotes the rapprochement of science and production.

The enterprises of the experimental-production base play an important role in creating the conditions for the development of fundamental research, in providing a high degree of completion of applied designs and in bringing them to the industrial level. We are firmly convinced that the use of this base makes it possible to truly develop fundamental science and with the greatest efficiency realize its achievements in new technologies.

The materials technology is being successfully developed at the academy. In the light of the measures planned by the Party and the government for improving the economic mechanism, this trend seems particularly important to us. The problems of materials and the organization of such leading branches as metallurgy and machine building are especially acute today.

The development of these branches is a very important government-wide task. After all they form the foundation of the economy. Circumstances are such in these branches that we are again and again forced to direct our attention to unresolved questions. Some figures are worth pondering again. In the

USSR 1.5 tons of steel are used to produce one ton of rolled product; in the USA this indicator amounts to 1.3 and in Japan it is 1.2. The structure of Soviet rolled product assortment suffers a serious shortcoming - the percentage of hot-rolled and cold-rolled sheet steel is very low.

The Soviet Union, birthplace of the continuous pouring of steel, unfortunately lags behind in the use of this progressive technology. Next year the percentage of steel poured by the continuous method will reach 10.8 percent in the USSR, while in Japan they have poured approximately 41 percent of all steel using this method.

Over a period of several years I have had to participate in the work of a specially created group of scientists and specialists, who each year are given the task of analyzing the status and plans for the further development of ferrous metallurgy. In our conclusions we have several times pointed out that questions concerning the production of pig iron, steel and rolled product must be viewed in close context with the problem of the consumption of metal, and not independently.

We must be concerned about the fact that over a period of the last ten years, for example, the coefficient of the use of rolled steel in machine building has stabilized at around .7 percent with no signs of its being lowered. Today the USSR is producing substantially less finished product from each ton of metal than the USA, Japan and West Germany. The reasons for this alarming situation are well known. On the one hand, it is connected with the unsatisfactory structure of the production of metal products, including nonferrous metallurgy (for example, the USSR clearly does not have enough rolled aluminum); on the other hand, it is connected with the sharp lagging of mill production in machine building. The amount of mechanical processing is still too great. In the last ten years the amount of shavings has increased nearly 1.5-fold and now exceeds eight million tons per year. At the same time the amount of forge and press processing, which is distinguished by significantly less losses of metal than in machine tool processing, is totally unsatisfactory. Each year there is an increase in the production of metal cutting tools, but at the same time we do not have enough forge and press equipment.

If the most energetic measures are not taken to radically improve the structure of mill production in machine building on the basis of the latest low waste and waste-free technologies, it will be difficult to solve the problem of meeting the needs of the national economy for metal.

It should also be pointed out that in developed capitalist nations from year to year the output of cast steel in relation to the production of rolled steel is steadily declining. In Italy, for example, over a fifteen year period from 1960 to 1974 the ratio of output of cast steel to rolled steel declined from 1.3 to .8 percent; in 1976 it amounted to .6 percent. Similar

trends are characteristic for other nations, including the USA. In the USA, however, the structure of metal consumption is improving more slowly than in Japan and West Germany, for example. What is the USSR doing? Unfortunately, we have too great a percentage of cast steel, which leads to unjustifiably large losses of metal.

It should be noted that with the active participation of scientists there have already been designed basic trends for the further development of several crucial branches of the national economy, including the prospect for the development of ferrous metallurgy in the Soviet Union up to the year 1990. The trends call for the further improvement in the assortment of ferrous metals, raising their quality and consumption properties needed for the more complete and efficient use of metals. Such a path of development for the metallurgical production will make it possible to decrease the expenditure of metal at all stages of conversion and to reduce capital expenditures for the extraction of raw materials and fuel.

In the near future the industrial assimilation of several hundred new grades of steels and alloys will be accomplished. Particular attention is being given to the more progressive ways of producing steel that is smelted, in particular, in electroslag, vacuum-arc, vacuum-induction, electron-beam and plasma furnaces. Rolled metal from metal obtained by methods of special electrometallurgy is increasing approximately 3-fold.

It is time to intensively develop a direct reduction of iron from iron ore concentrates and its subsequent new conversions. The development of the industry for the direct reduction is made necessary by the present reduction of coking coals, the successes of mining and enrichment technology and several other reasons. The direct reduction method requires significantly fewer capital investments while simultaneously making it possible to obtain steel with a minimal content of harmful admixtures. It is necessary that the productivity of the installations of direct reduction reach the productivity of blast furnaces - 8 - 10 thousand tons of metalized raw materials in a 24-hour period - in the near future.

We continue to be slow in the practical application of powder metallurgy on a large scale. L. I. Brezhnev, speaking at the November (1979) Plenum of the Central Committee of the CPSU, stressed to those in attendance the need to more rapidly and boldly develop powder metallurgy, which can provide our national economy with a great deal.

Statistics show that the use of 1,000 tons of parts from powders in machine building frees from 2 to 2.5 thousand of rolled metal or castings, approximately 80 units of metal cutting machine tools and 190 workers. In cost terms approximately 1.5 million rubles are saved per 1,000 tons of manufactured articles.

Powder metallurgy methods create basically new materials for the atomic-powder machine building, for the cryogenic and space technology and for the technology of high pressures. The new machines, mechanisms and instruments that are manufactured from these materials can operate in extreme conditions. The use of steel powders, alloy powders and powders of infusible compounds for the population of wear-resistant covers and covers with special properties makes it possible to considerably increase the resistance of metal constructions, parts for machines and instruments, and to sharply reduce losses of metal. In the Ukrainian SSR Academy of Sciences a great deal of attention is being given to questions of powder metallurgy. The Institute of Problems of Material Science has become the Soviet leader in this field. It coordinates the work of 130 Soviet scientific-research organizations and industrial enterprises.

It is quite clear that the practical successes of metallurgy as an important governmental matter will largely depend upon the achievements of Soviet science, the drive to adopt the results of fundamental research into production and their embodiment in progressive technology processes and in new technology.

But the development of the metallurgical and machine building branches does not hinge solely upon the metallurgists. Long-range plans take this into consideration. Ahead is serious and difficult work in creating a new system of planning the production of metal products, which should be free of those serious shortcomings that hindered us previously. This includes, for example, criteria for rating produce output by weight or by cost. In all likelihood, as concerns estimating the actual consumer usefulness of product, it would be necessary to introduce such a planning indicator as the coefficient of the use of metal and the extent to which non-metallic materials replace steel.

All of these problems must be solved without delay in order to fulfill the decree of the Central Committee of the CPSU and USSR Council of Ministers "concerning the improvement of planning and strengthening the influence of the economic mechanism on raising production efficiency and the quality of work." This decree calls upon workers in science to rapidly implement in the national economy scientific-technical discoveries and designs intended to increase the growth rates of labor productivity and product quality. [58-8927]

8927
CSO: 1842

USSR

INVESTIGATION OF THE PHASE COMPOSITION OF SURFACE FILMS FORMED DURING ELECTROCHEMICAL TREATMENT OF MOLYBIDENUM, TITANIUM, ALUMINUM AND NICKEL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 5, Sep-Oct 79 pp 29-31

KUDIMOV, YU.N., KRIVOBOKOV, YU.A. and MOSKALENKO, M.B., Novocherkassk

[Abstract] Surface films formed during electrochemical treatment of Mo4-1 molybdenum, VT1-0 titanium, A-5 aluminum, and NK-02 nickel foils were examined for phase composition. The treatment conditions were 20-30 A/cm^2 at 20-25°C, velocity of the electrolyte stream 10-15m/sec, interelectrode gap 0.1-0.5 mm. The following electrolytes were used: 25% $NaNO_3$ + 5% NaCl for molybdenum, 15% NaCl+ 2% KBr+ 2.5% KI+ 0.5% $NaNO_2$ for titanium, 15% $NaNO_3$ + 5% NaCl for aluminum, and 15% NaCl+ 2% Na_2HPO_4 for nickel. The analyses were performed with an EMR-100 electronograph operating in the reflection mode at an accelerating voltage of 75 kV, with an NaCl crystal for calibration. The oxides were found to be MoO_2, TiO_2 (rutile), Al_2O_3+ $Al(OH)_3$, and Ni+ $BNi_2O_3.H_2O$, respectively. Rinsing of the surface after treatment completely removed the electrolytic salts. On the basis of these and thermodynamic data, the possible reactions occurring at the surface at attainable anodic potentials and during subsequent desiccation are suggested. References 8: 5 Russian, 2 Western.
[62-2415]

USSR

UDC 669.15

AMORPHIZATION OF METALLIC ALLOYS UNDER LASER ACTION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 5, 1979 pp 1118-1120 manuscript received 27 Jun 79

KYASHKIN, V.V., ZHDANOV, G.S. and MIRKIN, L.I., Moscow State University imeni M.V. Lomonosov

[Abstract] Materials are generally stronger mechanically and more resistant to corrosion in the amorphous state than in the crystalline. Quenching a metal or alloy from a melt at rates within 10^6-10^{10} K/s will produce an amorphous structure, and a study was made concerning the feasibility of using a laser beam for this purpose. Accordingly, with a calorimetrically controlled neodymium pulse laser, binary Cu-Zr and Ni-Nb alloys were deposited from equiatomic powder mixtures on bulky Cu and Ni substrates, respectively. The microstructure of the alloys were examined by x-ray

diffractometry and microhardness tests. The results indicate that amorphization occurs only within a very narrow range of process conditions, even a 10-15% deviation from the optimum laser energy level already resulting in a crystalline structure. Amorphous structures produced by tightly controlled laser action were, furthermore, found to be much harder not only than structures of the component materials but also than amorphous alloy structures produced by quenching from the liquid state. The article was presented by academician N.V. BELOV on 13 June 1979. Figures 2; references 9: 5 Russian, 4 Western.
[60-2415]

USSR UDC 666.76.01+621.315.61+539.4

INVESTIGATION OF THE STRENGTH OF CERAMIC MATERIALS UNDER FORCE AND THERMAL ACTIONS. REPORT 1. YTTRIUM OXIDE

Kiev PROBLEMY PROCHNOSTI in Russian No 10, Oct 79 pp 46-50 manuscript received 7 Feb 79

GOGOTSI, G. A., ZAKHAROV, I. A., KUSHNIRENKO, A. M., and LUKIN, YE. S.
Kiev, Moscow, Institute Problems of Academy of Science and Moscow Chemical Technology Institute UkrSSR

[Abstract] Results are presented from investigations into the strength of yttrium oxide-base ceramics. After samples were produced by semi-dry pressing at 1000 kG/cm^2 they were heated at the rate of 200 degrees/min from initial temperatures of 20 and 800°C and tested for tensile strength, elasticity and deformability. Yttrium oxides were found to be less strong than aluminum and magnesium oxides but equal in deformability. All the yttrium oxides had the same magnitude of critical temperature drop where cracks of critical length are formed. It is only when a dense crack network forms from thermal loading that there is any loss in the modulus of elasticity. For thermally damaged samples there was no increased deformability associated with subcritical crack growth and no increase in crack depth. The technology of producing yttrium oxide ceramics has no effect on the features of failure and there refractories are well suited for use as electric insulating materials. Figures 5; references 8: 6 Russian, 2 Western.
[57-6368]

USSR UDC 620.186.4;669.245:539.27

DEVELOPMENT OF DISLOCATION STRUCTURE IN THE PROCESS OF CREEP OF HEAT-RESISTANT NICKEL ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 35-39

TRAVINA, N. T., NIKITIN, A. A., and ZIMINA, L. N., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Heat-resistant nickel alloys EP202 (Kh67MVTYu) and EI661 (KhN60-MKVYu) were used to study dislocation structure and movement in the different stages of creep. Both alloys were homogenized at 1175°C for six hours, air cooled and aged: EP202 at 850°C, 15 hours, and EI661--at 1000°C, four hours,+ 900°C, six hours, +850°C, 10 hours. EI661 passed through stages of creep when subjected to tensile testing at 850°C. The first stage of creep had the slowest rate and the second stage the fastest. The second stage revealed changes in the intercrystalline structure. The creep rate remained the same in the second stage for high-temperature nickel alloys if they contained a moderate amount of strengthening phase, uniformly distributed in the matrix. In this case deformation was accomplished by the gradual propagation of unit dislocations leading to crystallographic slip. In alloys with a large amount of strengthening phase, creating fields of elastic distortions, the development of plastic deformation occurred non-uniformly and the second stage of creep had several sections with a constant but differing rate of deformation. In EI661 the slow creep rate in the first stage was caused by dislocations fastening themselves around the strengthening phase particles. The accelerated rate in the second stage was caused by an increased mobile dislocation density. Creep rate in the third stage was the result of dislocation propagation preventing coalescence of the alpha'-particles into plates. Figures 1; references 7: 6 Russian, 1 Western. [55-6368]

USSR UDC 669.27'298:669.018

INTERACTION OF THORIATED TUNGSTEN AT 1200-1600°C WITH DIFFERENT METAL MATRICES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 12-15

MIROTVORSKIY, V. S. and OL'SHEVSKIY, A. A.

[Abstract] A study was made of the interaction of 0.5-mm-diameter VT7 tungsten alloy fibers with Fe, Ni, Co, Ti and Cr binary alloys alloyed with 5, 10 and 25 mass % of one of the elements listed above or with Al, Cu, Si, Zr, Nb, Mo or W. Annealing of the composites was done at 1200-1600°C

for one hour. For an Fe-base alloy annealed at 1200-1400°C the fiber/matrix interaction increased sharply, the fiber recrystallized, and a thick layer (12-15 microns) of hard and brittle intermetallides formed at the fiber/matrix interface. Fe alloyed with 5-25% Al annealed at 1300°C for one hour or Fe alloyed with Si, Ti, Zr, Nb, Cr, Mo or W annealed at 1200°C for one hour did not lead to the formation of an interaction zone. A large portion of the binary alloys did not have recrystallized fibers after treatment at 1200-1300°C. Fe, Cr, Co and Ti are recommended for use as the base material for heat-resistant composites operating at 1300°C since these elements diminish recrystallization and dissolution of the fiber without significant loss of strength. Cr-base composites can be used at 1400°C and Ti-base composites at 1500°C. References 6: all Russian.
[55-6368]

USSR UDC 620.17:669.295+669.14

CONTACT PHENOMENA AND THEIR EFFECT ON THE STRENGTH OF TITANIUM-STEEL JOINTS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 11, Nov 79 pp 8-11

KRISHTAL, M. A. and KOZLOV, V. F.

[Abstract] The nature and properties of phases in the boundary zone and their effect on the strength of Ti-steel joints were studied using 22 bimetallic pairs of iron-carbon alloys containing 0.004-0.45% C with alloys VT1-1, Ti-6% Al-4% V and Ti-6% Al-4% V -6% Zr as well as pairs with a sublayer of dynamo steel E13. The bimetals were produced by rolling three- and four-layer packets at 850-1050°C and then annealing them in a vacuum at 600-1150°C with soaking for 150 hours. When the carbon content in the steel was 0.1-0.4% and rapid heating was done (250°/min) the beta + TiFe liquid-phase eutectic was formed due to the simultaneous supersaturation of the beta-Ti with iron and precipitation of TiFe. A significant amount of heat was also liberated and the bimetal volume shrank slightly with the formation and relaxation of stresses. The optimum annealing mode for steel 20K + E13 (sublayer) and titanium alloys was 850° for three hours which yields a bimetal strength of 15-15.5 kgf/mm^2 and a bend angle of 180°. Figures 4; references 16: 11 Russian, 5 Western.
[55-6368]

USSR UDC: 669.28

A STUDY OF THE PROPERTIES OF A NICKEL EUTECTIC ALLOY PRODUCED BY DIRECTED CRYSTALLIZATION WITH MOLYBDENUM, ALUMINUM AND CHROMIUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 121-124, manuscript received 21 Apr 79

NESTEROVICH, L. N., KUPCHENKO, G. V., IVANOV, N. P., Minsk

[Abstract] Directed crystallization of alloys was performed by the Bridgeman method at 1-4 cm/hr. The mechanical properties of an alloy containing 35 vol.% molybdenum fibers were determined at 900-1100°C using 5-mm-diameter specimens. The short-term tensile strength of the eutectic was 40-45 kgf/mm^2 at 1100°C. The alloy also had good ductility. Relative elongation at 1100°C was 20%, necking down - 48%. The 100-hour strength of the alloy at 900°C was 22-23 kgf/mm^2, 11-12 kgf/mm^2 at 1000°C. When some of the Mo in the alloy was replaced with Cr these excellent physical properties were retained and oxidation resistance at high temperatures was improved. Figures 4; references 3: all Russian.
[64-6508]

USSR UDC: 535.211

PRODUCTION OF SIMPLE ANALYTIC EQUATIONS DESCRIBING THE PROCESS OF HEATING OF METALS BY CONCENTRATED ENERGY SOURCES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 3-11, manuscript received 18 Jun 79

RYKALIN, N. N., UGLOV, A. A., SMUROV, I. YU., LOBANOV, V. S., Moscow

[Abstract] A study was made of the heating of metal by concentrated energy fluxes distributed normally. Such fluxes included laser beams, electron beams and relatively low accelerator voltages, gas flames, ion beams, etc. The radiation pulse was considered rectangular, the heated body - semiunlimited. Phase transitions and heat loss from the surface were not studied. This made the solution of the problem simple by the method of sources or by integral transforms; however, the solution was then expressed as an integral which cannot be written in elementary functions, making it difficult to use in practice. The authors developed a method to produce simple approximate analytic expressions in place of this integral, and analyzed the equations thus produced. The method is applicable to other problems, as well, such as the heating of metal by moving heat sources, heating with different shapes or radiation pulses, heating by 3-dimensional heat sources, etc. Figures 4; references 12: all Russian.
[64-6508]

USSR UDC: 539.4.0193:669.292

BLISTERING OF OKh16N15M3B STEEL UPON BOMBARDMENT WITH He^+ IONS AT E = 0.3-1.8 MeV

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 29-32, manuscript received 20 Feb 79

TOLSTOLUTSKAYA, G. D., PIVOVAR, L. I., GUSEV, V. A., NEKLYUDOV, I. M., KHAR'KOV

[Abstract] The variation in blistering parameters (type and shape, surface density and diameter of blisters, thickness of covers) as a function of bombardment conditions and conditions of subsequent annealing of specimens was determined for bombardment of type OKh16N15M3B steel, as delivered and after vacuum remelting. A scanning electron microscope was used to study the surface of the specimens. The experimental values of thickness and area of the separated surface layer were used to calculate the erosion factors for the steel bombarded with helium ions at from 0.3-1.8 MeV. The coefficient varied from 0.4 to 2.0 at/ion. Figures 3; references 9: 4 Russian, 5 Western.
[64-6508]

USSR UDC: 533.9:541.124-16

REDUCTION, EVAPORATION AND MELTING OF MATERIALS IN A STREAM OF GLOWING GAS (PLASMA)

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 6, Nov/Dec 79, pp 48-51, manuscript received 20 Apr 79

NOVIKOV, V. S., Kiev

[Abstract] The study was made in a channel whose walls were made of a machined material. A steady flow of a radiating gas (plasma) containing a reducing gas flowed through the channel. The gas diffused from the flow to the walls and reduced them. At high temperatures, the reaction occurred in the diffusion area. The problem of melting of the body was studied as a function of heat exchange between the gas flow and the surface, and also the intensity of the process of melting. This approach to analysis of the interactions between a radiating gas and the walls of a channel can also be used for analysis or processes in the melting zone of a blast furnace. References 2: both Russian.
[64-6508]

USSR UDC 669.24'26'25:669.094.3

EFFECT OF MOLYBDENUM, TITANIUM, YTTRIUM, AND RARE EARTH METALS ON THE OXIDATION PROCESS IN Ni-Cr-Co ALLOYS

Moscow IAN SSSR, METALLY in Russian No 6, 1979 pp 212-217 manuscript received 16 Jun 78

LAZAREV, E. M., SAMARINA, A. M., KOROTKOV, N. A. and LEVANOV, V. I., Moscow

[Abstract] Ni-base alloys containing 15% Cr + 12% Co were experimentally treated with 1% Mo, 2% Ti, 0.1-1.0% Y, 0.1-0.5% La, 0.2% Nd, 0.2% Sm, and thereupon their oxidation kinetics was investigated by plotting kinetic curves as a function of periodic weighing of the specimens. Treatment with Mo as well as jointly with Mo and Ti was found to enhance the high-temperature strength of these alloys (change in weight of specimens after 100 hr of oxidation decreased by a factor of 3.4) Treatment with minute amounts (up to 0.05%) of r.e.m. had virtually no effect on the high-temperature strength of the alloys, but on the other hand it markedly enhanced the strength of adhesion (oxide film), thus preventing scale spallation between scale and metal. In terms of their effect on strength of adhesion between scale and metal, the r.e.m., when added in equiatomic quantities (0.08 at%) follow the sequence of increase in their atomic numbers. The greatest effect is produced by treatment with samarium. These findings are of interest to the development of permanent composite metal-porcelain stomatological prostheses. Figures 4; references 12: 5 Russian, 7 Western. [70-1386]

USSR UDC 669.017:537.32

ELECTROPHYSICAL PROPERTIES OF Zr-Ti AND Zr-Hf ALLOYS

Moscow IAN SSSR, METALLY in Russian No 6, 1979 pp 195-199 manuscript received 16 Oct 78

SAVIN, V.I., LESNAYA, M. I. and OVDEY, V. N., Kherson

[Abstract] The concentration dependence of magnetic susceptibility, Hall coefficient R, resistivity o, and thermo-emf oc-alloys of Zr-Ti and Zr-Hf were investigated, as were their o and within the 100-1300°K temperature range. For both types of alloys the concentration dependences of lattice periods and physical properties were characteristic of systems with complete mutual solubility. Zr-Hf alloys displayed an additive change in . The differing polarities of R and in Zr-Ti alloys as well as the pattern of the concentration dependences of R and for Zr-Hf alloys correspond to a mixed electron-hole nature of condution. The change in R and in the Zr-Ti alloy with increase in content of the second constituent--whether Zr or

Ti--corresponds to an increase in the contribution of electrons to the transfer process. The temperature dependences of ρ and within the 100-1300°K range display a number of anomalies which may be assoicated with an increase in the overlap between the Brillouin zone and the Fermi surface. Figures 4; references 11: 5 Russian, 6 Western.
[70-1386]

- END -

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JPRS 75724

19 May 1980

USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 68

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JPRS 75724

19 May 1980

USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 68

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UDC 669.7:621.762

PROSPECTS OF ELECTROTHERMAL PRODUCTION OF ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 58-61

KALUZHSKIY, N.A., DOBATKIN, V.I., GOPIYENKO, V.G., LITVINTSEV, A.I., CHEREPANOV, V.P., KISELEV, V.P. and SHMAKOV, Yu.V.

[Abstract] Tests were conducted with a new design of aluminum alloy granulator with a capacity of up to 5,000 kg/hour for the purpose of demonstrating the economic feasibility of producing high-silicon aluminum alloys with new properties, for example high plasticity and mechanical strength, by the electrothermal process. This process imparts high strength and plasticity to Al-Si alloys with 17 and 25 percent silicon by virtue of rapid crystallization and refinement of the microstructure of the alloy. Tests conducted by Soviet machine-building and instrument engineering enterprises demonstrated the cost effectiveness of the process by way of example of the alloy AL-25, in which 400 kg of aluminum per ton of alloy are replaced with cheaper Al-Si primary alloy without a sacrifice of mechanical properties, and disclosed the promising prospects of high-silicon alloy processing by powder and granule metallurgy techniques. References 10: 8 Russian, 2 Western.
[93-7872]

UDC 669.715:621.74

EXPERIENCE IN THE PRODUCTION OF LARGE-INGOT ALUMINUM ALLOY CASTINGS FOR THE AUTOMOTIVE INDUSTRY

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 94-96

KHOKHLEV, V.M., KUZNETSOV, B.L., STEPANOV, Yu.N., MAURITS, I.I. and MEDVEDEVA, L.N.

[Abstract] Two different large-ingot casting alloys were delivered by the Dnepr aluminum mill to the Volga and Kama automotive plants for testing to determine the advantages of using large-ingot aluminum alloy castings in the automotive industry. The alloys were AL4K, based on primary molten aluminum and crystalline silicon with up to 0.7 percent Fe. The alloys were smelted by two different processes, during which samples were taken to determine porosity and concentration of gases and iron impurities. The test disclosed that these alloys satisfy current requirements, and that the delivery of ingots weighing up to 600 kg offers economic and industrial advantages over the 15 kg ingots currently being delivered to the automotive industry for casting various truck parts. The total

annual saving for the national economy will be 1.3 million rubles. Large-ingot aluminum castings can satisfy the requirements of the automotive industry and other sectors of the national economy, but their adoption will be delayed by the lack of the necessary smelting facilities and by the failure of most industrial enterprises to accept large-ingot castings for remelting.
[93-7872]

UDC 629.735.33.015.43:539.219.2

CRACK DEVELOPMENT IN AIRTIGHT FUSELAGE PANELS UNDER SIMULTANEOUS CYCLE LOADS DUE TO SUPERCHARGE AND HIGH-FREQUENCY VIBRATION

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 80 pp 63-66 manuscript received 12 Dec 78

MOZZHEROVA, N. A., Central Institute of Aerohydrodynamics imeni N. Ye. Zhukovskiy, Zhukovskiy

[Abstract] An experimental study was made to determine the effect of high-frequency vibration due to pressure fluctuation in the air stream near propellers on the rate of cracking in the sheath of an airtight fuselage. Thin (860 x 1000 mm) cylindrical panels made of the D16AT aluminum alloy with a radius of curvature r = 1750 mm were tested, each panel consisting of two 1.5-mm-thick strips lap-joined and reinforced with two hoops and four stringers. These panels, mounted in a rigid steel fixture, were first subjected to excess pressure inside varying from 0 to 0.5 kgf/cm^2 at a frequency of 0,2 Hz with the hoop stress in the sheaths varying from 0 to 4.6 kgf/mm^2. In the second test series the panels were subjected to supercharge combined with high-frequency vibration for 21-min-long periods followed by pressure dropping between cycles. Experimental data on the distribution of static stresses along and normal to a crack, interpreted theoretically, indicate that vibration accelerates the cracking process. The general trend of the cracking process was found to be similar in both modes of loading, characterized by slow cracking up to a critical crack length within 90-100 mm and fast cracking beyond, also similar to its trend in the case of loading in uniaxial tension with simultaneous exposure to noise. For design purposes, in turn, theoretical relations are corrected here to agree with experimental data. Figures 5; references 8: 2 Russian, 6 Western.
[123-2415]

UDC 620.194

INVESTIGATION OF THE TENDENCY OF V93pch ALUMINUM ALLOY TOWARD CORROSION CRACKING IN A 3.5% NaCl SOLUTION

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 28-31

BATRAKOV, V. P., ZHILIKOV, V. P., KAFEL'NIKOV, V. V. and KORNAUKHOV, B. Ye., All-Union Institute of Aviation Materials, Moscow

[Abstract] A double cantilever beam method was used to study corrosion cracking in V93pch aluminum alloy from which the coefficient of stress intensity K_I was determined. Two unspecified heat treatments were used: one to increase strength properties and the other to diminish corrosion cracking tendencies. The ratio of K_{Iscc} in lateral and longitudinal directions of crack movement was close to the ratio of K_I values, regardless of heat treatment, which led to the conclusion that the effect of a corrosive medium is the same in both directions. The difference in the paths and levels of K_{Ic} and K_{Iscc} for samples with a different direction of crack growth was explained by some anisotropy of alloy properties. Crack growth rate of V93pch, slow when K_I is close to K_{Iscc}, speeds up rapidly with increased K_I. Figures 3; references 6: 2 Russian, 4 Western.
[104-6368]

UDC 669.721:620.1

NONDESTRUCTIVE TESTING OF MECHANICAL PROPERTIES OF MAGNESIUM PLATES AND SHEETS

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 96-97

DENISOV, S. S.

[Abstract] An experiment was conducted to determine the feasibility of testing hot rolled magnesium plates and annealed magnesium alloy sheets by the nondestructive eddy current testing technique, whereby electrical conductivity is measured with an induction tester without damaging the surface, and for which there is no need to prepare special test specimens. The technique is based on a correlation between mechanical properties and electrical conductivity. The nondestructive technique produces results just as good as destructive testing, will improve the reliability and productivity of testing and will produce a considerable annual saving.
[93-7872]

UDC 539.219.3:546.82:546.45

BERYLLIUM DIFFUSION IN TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDINIYE in Russian Vol 48, No 3, Sep 79 pp 663-665 manuscript received 26 Jun 78, after revision 19 Feb 79

SHABALIN, A. N., GLADKOV, V. F., GRUZIN, P. L. and SVETLOV, A. V., Moscow Engineering Physics Institute

[Abstract] The best dopant for preventing oxidation of titanium alloys is beryllium, which appreciably improves corrosion resistance even in concentrations as low as hundredths of a percent. The authors used the radioactive tracer method to study the diffusion of beryllium in cast alpha and beta titanium. The experiments were done on vacuum-melted VT-1 titanium with major impurities of 0.25 wt.% iron, 0.08 wt.% carbon, 0.012 wt.% hydrogen, 0.05 wt.% nitrogen and 0.15 wt.% oxygen. An aqueous solution of $BeCl_2$ tagged with the radioactive isotope ^7Be was applied to the carefully polished surface of the specimen. The treated surfaces of two specimens were placed in contact, the specimens were wrapped in beryllium foil and annealed in vacuum at about 400°C, after which the annealing chamber was filled with helium. It was found that the coefficient of volumetric diffusion of beryllium in alpha titanium at 990-1130 K is described by the formula

$$D = \left(14^{+31}_{-9}\right)\cdot 10^3 \exp\left(-\frac{62100\pm 2400}{RT}\right).$$

Figures 2; references 10: 7 Russian, 3 Western.
[114-6610]

UDC 561.0.55

EFFECT OF TECHNOLOGICAL COATINGS ON THE STRENGTH OF TITANIUM ALLOY STAMPED PARTS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16 No 1, Jan-Feb 80 pp 106-107 manuscript received 21 Nov 77

KRIVENKO, M. P., ROXENENKOVA, V. A., SOLNTSEV, S. S., ARZHAKOV, V. M. and ZHUKOV, N. D., All-Union Institute of Aviation Materials, Moscow

[Abstract] VT5-1 and VT-9 titanium alloys coated with EVT-24 and EVT-24K coatings were fatigue tested after the dross-applied coatings were removed either by blasting with corundum or by etching. The fatigue strength of VT-9 with the EVT-24 was 40% higher than uncoated stampings while with the EVT-24K coating this value amounted to 60%. This was believed to be due to the brittle gas-saturated layer. Coating EVT24 does not have much effect on the fatigue of VT5-1 when that alloy is stamped in the alpha+beta region; however, samples made while in the beta-region were 1.7 times stronger with this coating. Both protective and lubricating properties were thought to give the improved fatigue strength when the samples were made in the alpha+beta region with only good protective properties generated by the beta-region. Removal of the gas-saturated layer was responsible for increasing the fatigue limit of VT-9 and VT5-1 coated with EVT-24. Figures 3; references 3: all Russian. [104-6368]

UDC 669.018.95:669.295:546.281'261

THE INTERACTION KINETICS OF COMPONENTS IN A COMPOSITE MATERIAL CONTAINING A TITANIUM ALLOY AND SILICON CARBIDE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERILAOV in Russian No 1, 1980 pp 134-136 manuscript received 28 Apr 1977

SOKOLOVSKAYA, Ye. M., GUZEY, L. S., ZAYTSEV, B. G., CHUNIKHINA, L. L., and SHULEPOV, V. I., Moscow

[Abstract] The highly heat-resistant titanium alloys based on Ti-6.6Al-3.3Mo-1.8Zr-0.3Si were tested at temperatures above and below the heat at which the alloy phase emerges by hot pressing in an approximate 10^{-4} vacuum with a mixture of the granular alloy and fibers of silicon carbide of 100 mkm diameter. The samples obtained were then annealed in a vacuum. Measurements of the zones of interaction showed that time and temperature factors were involved, with temperature variations being of the greatest importance in the phase transformation in titanium alloys. Direct comparisons were impossible due to lack of primary data. References 9: 4 Russian, 5 English
[95-12131]

UDC 621.762

AN INVESTIGATION OF INTERACTION PROCESSES BETWEEN COMPONENTS OF A COMPOSITE OF THE VT-6 TITANIUM ALLOY AND AN ALLOY BASED ON ALUMINUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980 pp 141-143 manuscript received 21 Apr 1979

VARENKOV, A. N., YEZHOV, A. A., KOSTIKOV, V. I., LEGKODUKH, A. M., MOZZHUKHIN, Ye. I., SHVARTS, V. I., and YAGUBCHIKOV, A. N., Moscow

[Abstract] Liquid AK4-1 aluminum alloy was poured onto the surface of VT-6 and EI-607 alloys that had been heated to the temperature of the aluminum alloy, in a $2 \cdot 10^{-5}$ vacuum for the VT-6 and with a flux layer at 750, 800 and 850° C for the EI-607. Isothermic contact in separate tests was maintained for 2, 5, 10 and 15 minutes with VT-6, and for 0.5, 3, 6, and 10 minutes for EI-607. The formation of a contact zone of complex structure and, after cooling, with a heterogeneous structure, was observed as a result of interaction. Both titanium and nickel were found to dissolve into the molten AK4-1 aluminum alloy, indicating the possibility of the formation of titanium and nickel aluminides. Increased time of isothermic contact brought increases in titanium and nickel content in the transition zone. Figures 2; references 4: all Russian.
[95-12131]

UDC 621.762.5:669.018.45:539.4

STRENGTH OF SINTERED Mo-Al_2O_3 AND Mo-ZrN COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 58-63
manuscript received 20 Apr 79

YEGOROV, F. F., KISLYY, P. S. and VERKHOVODOV, P. A., Institute of Problems of Material Science, Academy of Sciences UkrSSR, Institute of Superhard Materials, Academy of Sciences UkrSSR

[Abstract] An investigation was made of the effect of temperature, sintering time, porosity, grain size of the matrix and hardening phase on the strength of Mo-Al_2O_3(ZrN) cermets. The initial meterials were 99.8% pure Mo, 99.72% pure Al_2O_3 and 98.1% pure ZrN. The average size of the molybdenum particles was 3-4 μm, and of the Al_2O_3 and ZrN particles 1 μm. Bending strength was determined by application of a concentrated force to specimens measuring 5 x 5 x 35 mm, and compressive strength was determined on cylindrical specimens 8 mm in diameter and 10 mm high. If was found that the strength of Mo-Al_2O_3 cermets with up to 30 vol.% oxide increases with simultaneous reduction in porosity up to a solid-phase sintering temperature of 1800° C. At higher sintering temperatures, strength decreases even though density continues to increase. The strength reduction was attributed to weakening of the bond on phase boundaries. Liquid-phase sintering reduces strength due to intensified interaction on the phase boundary with liberation of MoO, MoO_2 and MoO_3 vapors, forming macropores that generate cracks during fracture. Fracture was initiated by cracking of particles under the action of internal cleavage stresses. Strength was determined by size and shape of the hardening particles as well as by the properties of the matrix grains. Strength of adhesion was greater than cohesion in the Mo-ZrN system; the reverse was true for the Mo-Al_2O_3 system. Figures 5; references 10: 8 Russian, 2 Western.
[92-6610]

UDC 539.376:539.4

FEATURES OF LOW-TEMPERATURE CREEP OF LAMINAR COMPOSITES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 630-635 manuscript received 7 Feb 78, after revision 10 Oct 78

YAVOR, A. A. and CHEBOTAREV, V. A., Volgograd Pedagogical Institute imeni A. S. Serafimovich

[Abstract] An investigation was the behavior of laminar composites with a copper, brass and aluminum matrix and refractory Nimonic reinforcement under creep conditions at 400° C. The initial stress was 90% of the

macroyield point. An analysis was made of the changes in the effect structure of the matrix layers under prolonged loading at high temperature. It was found that the behavior of laminar composites under these conditions is determined by deformation interaction of the components through the boundary between layers and is independent of the nature of load distribution between matrix and reinforcement. At temperatures of 40% of the absolute melting point of the reinforcing material or lower, and stresses below 90% of the macroyield point, plastic deformation does not occur because there is no accumulation of damage in the matrix layers, which represent the weakest part of the composite. Figures 3; references 13: 12 Russian, 1 Western.
[114-6610]

UDC 678.067.5:677.4:539.377

STRESS RELAXATION IN CARBON FIBER AT ELEVATED TEMPERATURES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 80 pp 3-9
manuscript received 13 Jul 79

MOSTOVOY, G. YE., RABOTNOV, YU. N., KOBETS, L. P. and FROLOV, V. I.,
All-Union Scientific Research Institute of Aviation Materials, Moscow

[Abstract] In a continuation of a study of stress relaxation in VMN-RK carbon fiber at 1200° C, the temperature range was extended upward and also the activation energy and the effective volume of relaxator elements characterizing the process kinetics were measured. All fiber specimens were 8.3 ± 0.16 μm in diameter and their average modulus of elasticity was 20,000 kgf/mm^2, with a 7.6% variance excluding the measurement error. They were either heated fast within 15-20 min or heat treated before relaxation for 1 hr and then thermomechanically treated during relaxation. This treatment was found to increase the thermal modulus of elasticity, but only at temperatures above 1500° C. The relaxation curves, measured at temperatures from 1200 to 2000° C, follow the trend typical of metals and polymers. The relaxation of tensile and compressive stresses proceeds similarly, the process being almost completed after 20-30 min. An analysis of the results based on the fibrilar model, indicates two relaxation mechanisms. Carbon fiber behaves below 1600° C like a brittle material with linear elastic characteristics and reversible changes in mechanical properties, it undergoes fast spontaneous graphitization with irreversible changes in properties within the 1600-1700° C range, till above 1700° C the mobility of even small clusters of atoms in the graphite-like layer of a much denser fiber material becomes high and relaxation occurs through slippage of this layer. Figures 5; references 7: 5 Russian, 2 Western.
[120-2415]

UDC 620.193.01:669.245:546.77

INVESTIGATION OF THE MECHANISM OF CORROSION STABILITY IN NICKEL-MOLYBDENUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 7-13 manuscript received 26 Oct 79

KOLOTYRKIN, YA. M., KNYAZHEVA, V. M., TSENTA, T. YE., KOZHEV-NIKOV, V. B., ZAKHAR'IN, D. S. and SVISTUNOVA, T. V., Scientific-Research Physico-Chemical Institute imeni L. Ya Karpov, Moscow

[Abstract] The behavior of nickel, molybdenum and alloys of these metals was studied where Mo content ranged from 2 to 30 mass %. To provide uniform grain size, the samples of Ni-30Mo were heated at 1200° C, Ni-20Mo at 1150° C and Ni-10Mo and Ni-5Mo at 1100° C and water quenched. These samples were then corroded in solutions of 1N HCl and 1N H_2SO_4 at 50° C. The principles of partial processes in the dissolving of the components in N-Mo alloys and surface composition changes as a result of corrosion were investigated using electrochemical and gamma-spectrometry as well as photoelectronic spectroscopy. The existence of two basic regions of potentials was established which had the greatest significance for industrial use of these alloys. Considerations were expressed about the probable mechanism of alloy corrosion stability according to which the high retarding action of Mo and investigated inhibitors (J^- ions, propynol) was caused by blocking active centers of the dissolving surface. Along with this, at adequate negative potentials, an additional retarding effect from the forming passive film, enriched with molybdenum oxides, was possible. Figures 4; references 16: 14 Russian, 2 Western. [104-6368]

KRIVBASS IRON ORE PRODUCTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 61, 13 Mar 80, p 1

[Article by L. Timirgaleyeva: "Records are Born Here"]

[Text] Krivbass now produces almost one half of the All-Union iron ore output. In its reserves and quality the basin is unique and is one of the most prominent in the world. But it began as a small pit, which has been transformed into a huge mining enterprise bearing the name of Feliks Dzerzhinskiy. Three of its shafts -- "Kommunar," "Saksagan'," "Gigant-glubokaya," and the "Severnyy" open pit -- yield about 8 million tons of metallurgical raw material.

The friendly Dzerzhinskiy collective has kept up a tradition for many years now -- completing the yearly plan on time and producing more ore than the plan called for. The miners did not change this in the current five-year plan. They have been the winners in the All-Union and republic competition among mining enterprises 14 times in a row.

The mine workers remember well the day when they received congratulations from the General Secretary of the CPSU Central Committee, President of the Presidium of the USSR Supreme Soviet L. I. Brezhnev on the occasion of their production of 1 million tons of iron ore above and beyond the plan.

The title of "Enterprise with a high level of production and good working conditions" has been awarded to the mine management many years in a row.

And now there is another achievement: a collective of the Order of the Red Banner of Labor of the mine management imeni F. Dzerzhinskiy has been recognized as the winner in socialist competition for 1979 and has been awarded the challenge Red Banner of the CPSU Central Committee, the USSR Council of Ministers, the VTsSPS [All-Union Central Trade-Union Council] and the VLKSM [All-Union Lenin Young Communist League]. The miners produced 54,800 tons of iron ore above the plan, overfulfilled the plan for realization of output, and increased labor productivity

by 1.9 percent more than the plan called for. In the same year, in the beginning of November, they completed their socialist obligations for the current five-year plan.

The minedrilling brigade of the UkrSSR State Prize winner, honored miner of the republic Anatoliy Grigor'yevich Tret'yak, was one of the first brigades in the Krivbass to complete its five-year plan, in the "Gigant-glubokaya" shaft. Having mastered the method of the brigade contract, the miners make every minute of work time count, use electric power wisely, and make optimum use of drilling mechanisms and tunneling complexes. By these actions the brigade saved about 2,000 rubles, and the cost of digging out one meter of underground workings was reduced by 0.7 percent.

Use of the brigade contract in underground extraction has been widely adopted in shafts of the mine management. The originators of this method now have a lot of followers. Now everyone here is proud of the successes of the best collectives, which are headed by the brigade foremen V. Likholit, N. Popov, V. Zamriy, B. Petukhov, Ye. Scrin and others.

In one year the Dzerzhinsky mine workers will observe the 100th anniversary of their enterprise, which is justifiably considered the standard bearer of Krivbass mining. The miners are now participating in the second birth of their minepit. Leading specialists of the enterprise, together with scientists of scientific research and planning institutes of the country, have opened up a development add enrichment of magnetite quartzites for the first time in Krivoy Rog, which until now have not been used. A concentrate of these quartzites, containing 67 percent iron, is already being produced on the redesigned first line of the enrichment plant. This is only the beginning. There are plans to expand the development and enrichment of the magnetite quartzites and to finish construction of the second line of the enrichment plant in order that, by using the voluminous capacity of the "Kommunar" shaft, the production of metallurgical raw material can be increased.

Socialist competition is being extended to all shafts of the mine management in preparation for the 110th anniversary of V. I. Lenin's birth. The miners have set themselves the goal of producing 15,000 tons of iron ore in excess of the plan by the jubilee of the leader, which is one half of the annual obligation.
[118-9424]

9424
CSO: 1842

UKRAINIAN FERROUS METALLURGY QUOTA FAILURES NOTED BY MINISTRY BOARD

Kiev PRAVDA UKRAINY in Russian No 14, 18 Jan 80 p 3

[Article: "Better Utilization of Metallurgy's Potential"]

[Text] Quotas relating to execution of the decisions of the November 1979 Plenum of the CPSU Central Committee and the directives and aims described in the address presented at it by General Secretary of the CPSU Central Committee, President of the Presidium of the USSR Supreme Soviet, Comrade L.I. Brezhnev, and the decrees of the December 1979 Plenum of the Central Committee of the Communist Party of the Ukraine were discussed at an extended meeting of the board of the republic's Ministry of Ferrous Metallurgy held in Dnepropetrovsk. Invited to the meeting were managers, secretaries of party committees, chairmen of trade union plant committees of enterprises and associations, personnel of the ministry and republic committee of the industry's trade union, and secretaries of a number of party obkoms in charge of problems relating to the industry.

The reader of the report--Minister Ya.P. Kulikov--and L.D. Yupko, the director of the Zaporozhstal' Plant, and A.A. Shvedchenko, the director of the Novomoskovsk Pipe Plant, Party Committee Secretary of the Zhdanovsk Azovstal' Plant Ye.I. Eskin and other speakers noted that at enterprises of the republic's ferrous metallurgy industry since the beginning of the five-year plan period definite work has been done on the re-equipment of production, dozens of powerful units have been put into service, and a number of metallurgical processes have been improved with the assistance of scientists. Rightfully regarded as right-wingers of the fourth year of the five-year plan period are the teams of the Donetsk imeni V.I. Lenin and Dnepropetrovsk imeni Petrovskiy metallurgical plants, the Nikopol', Novomoskovsk and Nizhnedneprovsk pipe plants, the Krivbassruda Production Association and the Yuzhnyy and Marganets ore concentration combines.

However, on the whole the industry did not cope with the plan quotas of the past year for the production of the most important kinds of products and technical and economic indicators worsened as compared with 1978. Subjected at the board's meeting to harsh criticism for the nonfulfillment of State quotas and unsatisfactory management of production were the

directors of the Krivorozhstal', Dneprovskiy imeni Dzerzhinskiy, Makeyevka, and the Kommunarsk metallurgical plants, the Avdeyevka, Zaporozh'ye and Zhdanovsk coking byproduct combines and the Dneprovskiy, Tsentral'nyy and Ingulets ore concentration combines.

Having made a profound analysis of the shortcomings, the meeting's participants pointed out ways for eliminating them and measures for improving the efficiency and quality of work in the concluding year of the five-year plan period. The entire increase in the production of cast iron--2.7 million tons, of steel--2.6 million tons, and of rolled metal--2.4 million tons, must be gained on account of the better utilization of existing plants. Measures have been provided for the intensification of technological processes. reducing the idle time of plants, improving the quality of products, and improving the planning and organization of production and the management of enterprises.

Great attention was paid to questions relating to strengthening the raw materials base and to the timely entry into service of projects for the recovery of iron and manganese ore and for the production of concentrate, pellets and coke. Plans have been made to expand the production of effective kinds of rolled metal which make possible a savings of metal in the national economy. The necessity was emphasized of closing all channels for the above-plan consumption of raw material and physical and fuel and energy resources, of strengthening production and labor discipline in every possible way, of strengthening the effectiveness of competition, and of supporting in a businesslike manner the creative initiative of workers and specialists.

Speaking at the extended meeting of the board were Politburo Member and Secretary of the Central Committee of the Communist Party of the Ukraine A.A. Titarenko and USSR First Deputy Minister of Ferrous Metallurgy D.P. Galkin. Ye.V. Kachalovskiy, first secretary of the Dnepropetrovsk Party Obkom, participated in the board's work.
[117-8831]

8831
CSO: 1842

UDC 621.3.038.8:621.78.001

FEASIBILITY STUDY OF TEMPERING WITH A CW GAS LASER

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 24-26

KOTSYUBINSKIY, O. YU., Experimental Scientific Research Institute of Metal-Cutting Machine Tools

[Abstract] The author calculates gas laser irradiation parameters that maximize the casehardening layer without melting the surface of the item being treated. The analysis is based on satisfaction of three conditions: 1) heating the metal to the temperature required for tempering with consideration of the high speed of the process; 2) additional heating to a temperature no higher than the melting point of the given material; 3) as all sections of the tempered layer are cooled to the martensite transformation temperature, cooling to any intermediate temperature must not cause premature breakdown of austenite. The proposed engineering method for calculating the thickness of the casehardened layer from laser parameters includes formulas for the specific heat flux and the specific power of the heat flux absorbed by the surface, the lasing time that ensures the necessary duration of cooling to a given temperature, the true cooling rate of the casehardened layer at this temperature, the rate of displacement of the laser beam over the surface, and the thickness of the casehardened layer. An example shows that the proposed technique is technologically feasible. Figures 2; references 3: all Russian.
[115-6610]

UDC 539.385:620.193.2:669.721.5

SOFTENING OF THE IMV6 MAGNESIUM ALLOY DUE TO FATIGUE

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 80 pp 35-39 manuscript received 5 Oct 78

GRINBERG, N. M. and SERDYUK, V. A., Physico-Technical Institute, Academy of Sciences of the Ukrainian SSR, Kharokov

[Abstract] A study was made of structural changes in the hot pressed IMV6 magnesium alloy (7.8% Y, 0.55% Mn, 0.4% Cd, 0.12% Al, 0.11% Ce) due to fatigue, Specimens of this alloy punched from strip and then polished, mechanically as well as electrolytically, were mounted in cantilever fashion and cyclically loaded in symmetric flexure with a constant strain amplitude = 0.0034 in air and in vacuum at room temperature and at 153° K. Microhardness measurements revealed a softening due to fatigue at room temperature in air, predominantly within the surface layer, which was also indicated by a decrease in the load amplitude after an increasing number of cycles. No softening was found to occur at low temperature. The life of specimens was greatly prolonged, fourfold to sixfold, in vacuum. According to the results of examination under an optical microscope, crack initiation is inhibited much longer at a low temperature and in vacuum both crack initiation and crack propagation proceed at much slower rates than in air. Figures 5; references 23: 13 Russian, 10 Western.
[123-2415]

UDC 539.385:669.721.5

EFFECT OF LOW TEMPERATURE ON THE KINETICS OF FATIGUE FAILURE IN MAGNESIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Fan-Feb 80 pp 73-76 manuscript received 25 Jan 79

SERDYUK, V. A., GRINBERG, N. M., MALINKINA, T. I. and KAMYSHKOV, A. S., Physico-Technical Institute of Low Temperatures, Academy of Sciences UkrSSR, Khar'kov

[Abstract] MA2-1, MA15, IMV6, MA21 and MA12 magnesium alloys were investigated to determine the degree of damage in the different stages of the fatigue process and to explain the effect of low temperature on the length of the individual stages. All the alloys except MA21 had an alpha-solid solution phase composition (magnesium-base HCP lattice) while MA21 had the alpha-phase plus the beta-phase with a lithium-base BCC lattice. Alloy samples were put under a cyclic symmetric and constant load at a frequency of 25 Hz which was 0.6 of their yield point at room temperature. Testing was done in a vacuum of 0.13 mPa at 20° and -120° C.

Results showed that the alloys could be divided into two groups according to their behavior at low temperature. The first group (MA15 and MA12) had increased durability at low temperature due to a longer stage of crack nucleation. The rate of crack growth, emerging beyond the grain limits, was faster at low temperature than at room temperature. Alloys of the second group had both an extended stage of crack nucleation and slowed growth rate at reduced temperatures. Alloys in the first group underwent brittle fracture while the others had a ductile micromechanism of fracture. These alloys of the second group had either a two-phase structure (MA21) or a metastable one which changed as a result of strain aging (IMV6). Apparently, the structural state manifests a varying degree of plastic deformation development in the process of fatigue from which, in turn, depends the rate and micromechanism of crack growth. Figures 3; references 4: all Russian.
[104-6368]

UDC 539.43:669.721.5:620.19

DEVELOPMENT OF FATIGUE CRACKS IN MA2-1 MAGNESIUM ALLOY SHEETS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 64-69 manuscript received 16 Dec 78

YAREMA, S. YA., OSTASH, O. P., ZINYUK, O. D. and VASHCHENKO, A. N., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] The principles involved in development of fatigue cracks were investigated for MA2-1 magnesium alloy where the load amplitude varied from threshold to critical. A total diagram of the fatigue failure in the alloy is presented and the characteristics of its cyclic cracking stability are determined. An anomalous phenomenon of crack growth rate jump was observed in the interval of K_{max} from 5.2 to 4.5 MPa·$m^{1/2}$. The possible causes for this phenomenon were felt to be the intergranular slip at that point in the cyclic duration. It is shown that, according to the characteristics of cyclic crack stability, related to specific weight, MA2-1 alloy exceeds V95AT1 alloy in the region of slow and fast crack growth rates and surpasses D16At alloy only in the region of average crack growth rates. Figures 5; references 14: 7 Russian, 7 Western.
[104-6368]

ACADEMICIAN MEL'NIKOV DISCUSSES MINERAL RESOURCES OF THE USSR

Moscow TRUD in Russian No 73, 28 Mar 80 p 2

[Article by Academician N. Mel'nikov, member of the Presidium of the USSR Academy of Sciences, Hero of Socialist Labor: "Conserve Mineral Resources"]

[Text] Mineral raw materials are a key item in the national economy. There are more than 20,000 proven mineral deposits in this country. The Soviet Union accounts for 28% of world mining output, while the U.S. share is 23-24%. If we bear in mind that Russia produced 20 times less volume of minerals than the United States, 10 times less than Great Britain, and five times less than Germany, our practical achievements will fall into perspective.

An extremely important advantage of the Soviet Union is that it can meet its own mineral resource needs. We must bear in mind, however, that development of a country's mineral raw materials base is achieved at the cost of enormous labor. Up to 40% of capital investment in industry is spent on exploration for and mining of minerals. Concentrated in these activities are 30% of the nation's productive resources and 18% of its labor resources.

Today even this is proving insufficient. Growing and developing industry -- and this is natural -- is demanding more and more mineral raw materials each year. This means that it is necessary to engage in additional expenditures on looking for and surveying new mineral deposits and construction of mining enterprises. And yet right now we could be producing 25-30% greater output at existing mines, plants and mills. And this additional output would cost the economy 50 to 75% less than utilization of specially-mined minerals.

How can this be achieved? There is only one way: by comprehensive utilization of ore bodies, fuller extraction of ore constituents during processing, for every mineral deposit is by its very nature an aggregate of one or several principal minerals and a number of secondary minerals.

What is required to achieve this? First of all development of new processes and their bold practical adoption. I shall cite several examples. In this country we have long been employing the geotechnological method of mining

sulfur. It is melted with hot water and drawn to the surface in melted form. This makes the mining operation easier and also cheaper and, of equal importance, helps increase labor productivity.

But the geotechnological method -- subsurface leaching, as it is called -- can also be employed for efficiently working reserves of other low-grade ores as well, where mining with other techniques is sometimes uneconomical. This method makes it possible to extract secondary constituents from mineral ores, metals left behind in mine and beneficiation mill tailings. We know that in a number of countries 20% of copper production is obtained by leaching. In this country adoption of this advanced technique is being delayed due to a lack of inexpensive reagents and special -- but generally not highly complex -- equipment.

The USSR Ministry of Nonferrous Metallurgy is also ignoring another promising method -- separate working of ores of different types. At the present time they are mined together, which makes subsequent processing very complicated, and frequently leads to a situation where certain constituents simply end up in the tailings. The separate processing technology employed in this country is imperfect and costly, and therefore is utilized to a very small degree only at the Almalyk Mining and Metallurgical Combine and at the Noril'sk Combine. Industry needs new, efficient solutions, which would make it possible more extensively to adopt separate processing in a practical manner.

Mined mineral raw materials are subjected to primary processing -- concentration or beneficiation. Today the most accessible mineral deposits, which are close to the surface, have become exhausted. The geologic conditions in which ores are mined have become more complex. The grade of the ore has also correspondingly declined. Therefore only improvement in beneficiation processes and conditions can increase recovery of valuable metals. We have had some success in this area. At the present time 7% more copper is being recovered from complex ores than in the recent past. The lead content of mined ores has declined by 0.2% in recent years. In spite of this, however, recovery of lead into concentrate has increased from 79.4 to 81.2% due to process improvement.

These examples, however, gratifying as they may be, cannot leave us entirely satisfied. Losses during primary processing are still fairly high. Recovery of a number of valuable metals during beneficiation sometimes does not exceed 60%. The situation is particularly unfavorable in the case of tin, nickel, and molybdenum. In nonferrous metallurgy there is considerable reserve potential for additional utilization both of primary and secondary constituents.

Calculations indicate that extensive adoption of combined technologies in processing Ural pyrite copper ores would make it possible to increase zinc production by 15%, copper production by 5-10%, sulfur production by 18%, and production of rare elements by a whopping 50%. Combined processing of complex ores makes it possible to recover copper, lead, zinc, tungsten,

and indium from these ores, in addition to tin. At the present time these elements, the total value of which is as much as 40% of the value of the recovered tin, is essentially lost.

The enterprises of the USSR Ministry of Ferrous Metallurgy also possess considerable potential for fuller utilization of ores. At the ferrous metallurgy mills and mines of Kazakhstan, for example, up to the present time they have been recovering only iron from the mined ore. The magnetite ores processed at the Sokolovsko-Sarbayskiy Mining and Beneficiation Combine contain 25 accessory constituents. The majority of these are simply relegated to the slag heap. Ore mined from the Lisakovsk ore body is a valuable complex raw material. In addition to iron, it contains aluminum, phosphorus, and vanadium. Only the iron is utilized, however, that is, 68% of the potential value of this ore.

We possess vast reserves of oxidized and mixed iron ores. The slag heaps of the Krivoy Rog Basin alone contain more than 300 million tons of ore with 38-45% iron content and approximately 500 million tons of oxidized quartzites. Millions of tons have also piled up in the area of the Kursk Magnetic Anomaly. Oxidized ores do not possess magnetic properties and therefore require a totally different beneficiation process. Research in this area has dragged on for years. The USSR Ministry of Ferrous Metallurgy is failing to display adequate concern about utilization of this valuable mineral raw material.

Recently there has been increased use of coal as a power-generating fuel. In connection with this there arises the problem of removing sulfur from coal, with sulfur a valuable chemical raw material in its own right. At the present time only one half of 1% of the sulfur contained in coal is trapped during combustion. Several years ago one fourth of the coking coal produced in the Pechora Basin was being burned as ordinary power-generating fuel. Such profligacy is totally unwarranted!

Our discussion on comprehensive utilization of raw materials would be incomplete if we did not mention the problem of recovery of waste materials. Each year mining enterprises pile up approximately 5 billion tons of overburden, while beneficiation plants relegate 700 million tons to the slag heap. These waste materials occupy more than 1 million hectares of fertile land, which of itself does enormous detriment to agriculture.

But the by-products of beneficiation plants, metallurgical plants, and thermal electric power stations contain highly valuable mineral raw materials, from which right now or in the very near future we could obtain meaningful products. In many cases it also proves feasible to recover ferrous, nonferrous, and even precious metals from coal waste products. It is a known fact, for example, that the slag discarded at some mining-industry plants in Eastern Kazakhstan contains two to three times the quantity of metals as in some ores.

How are these riches being utilized? Unfortunately, quite unsatisfactorily at the present time. In spite of the fact that the "Fundamentals of

Legislation of the USSR and the Union Republics on Mineral Resources" clearly formulate the requirement of efficient and comprehensive utilization of raw materials, up to the present time even in such well-developed mining-industry regions as the Urals and Northern Caucasus, only 10-13% of waste products are recovered.

Possibilities for their utilization are essentially unlimited. In the Angren coal field rock containing large quantities of quartz sand, limestone, refractory clay and kaolin is going into the spoil banks. And yet this rock could be used to produce glass, silicate brick, lime, porcelain, and earthenware. At the Kachkanar Mining and Beneficiation Combine, 25 million tons of rock is piled into spoil banks each year in the process of mining iron ore. Large quantities of crushed rock could be produced from this waste. In the Nikopol' Manganese Ore Basin more than 130 million cubic meters of rock is amassed each year, containing large quantities of ceramic and keramzit clays, quartz sand and construction limestone.

Some people are of the opinion that utilization of waste products is an unprofitable undertaking, since it requires construction of new and renovation of existing mining-beneficiation enterprises and the establishment of additional facilities, that is, considerable capital expenditures in the final analysis. But we should bear in mind that the cost of maintaining dumping and storage areas in the mining industry is also not cheap. At some enterprises outlays on establishing dumping and storage areas comprises up to 10% of total outlays on construction. In addition we should not forget about the land which, if the waste were utilized, we could return to agricultural use. And finally, we should also bear in mind that the earth's resources, although considerable, are not inexhaustible. Therefore, in spite of costs, we believe that utilization of waste materials is economically expedient.

In conclusion we should like to present a proposal. We believe that it would be beneficial to establish a number of special production-industrial associations, based on large mineral deposits, with a complete cycle of comprehensive processing of raw materials. These associations could become experimental testing grounds for developing the most efficient techniques of utilization of commercial minerals, adopting waste-free processing, which could subsequently be adopted at other enterprises as well.

Our nation possesses vast mineral resources. Mineral reserves comprise our greatest national wealth. But precisely this fact obliges us to manage these resources in a thrifty and economical mannner.
[122-3024]

3024
CSO: 1842

UDC 546:669.295.24

SELF-PROPAGATION HIGH-TEMPERATURE SYNTHESIS OF TITANIUM NICKELIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 7-11
manuscript received 14 Sep 78

BRATCHIKOV, A. D., MERZHANOV, A. G., ITIN, V. I., KHACHIN, V. N., DUDAREV, YE. F., GYUNTER, V. E., MASLOV, V. M. and CHERNOV, D. B., Siberian Physicotechnical Institute, Division of the Institute of Chemical Physics, Academy of Sciences USSR

[Abstract] Traditional methods of producing marmem alloys of the Nitinol type by melting or powder metallurgy do not always give adequate homogeneity for realizing shape-memory properties. It is shown that the degree of homogeneity can be enhanced by doing the first stage of synthesis in a combustion wave or high-temperature self-propagation process. Alloys based on titanium nickelide are produced by this method to determine the optimum parameters of the technique. An investigation was made of the effect of various parameters on the burning rate and the phase composition of the final product. The results showed that the high-temperature self-propagation method of synthesis is more effective than conventional procedures for making shape-memory alloys of this type. Figures 5; references 10: all Russian.
[92-6610]

UDC 621.762.274:621.357.12

ELECTROCRYSTALLIZATION OF IRON SINGLE-CRYSTAL WHISKERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 1-6
manuscript received 16 May 79

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[Abstract] Ultrafine metal powders with dendritic particles can be produced by electrolysis in a two-layer bath on a rotating cathode at fairly high rates of cathode rotation and low concentrations of oleic acid in the upper layer. Single-crystal whiskers are produced in such a bath at low rates of cathode revolution with high concentrations of oleic acid in the upper layer. The author describes the use of such a process for making iron whiskers on a disk cathode with a diameter of 50 mm, turning at a speed of 2 rpm in a two-layer bath with a current density of 15 mA/cm^2. The upper layer was a 10% solution of $FeCl_2$ (15 grams per liter). The technique can also be used to produce ultrafine powders of copper, silver, cobalt and other metals and alloys. Depending on the conditions of electrocrystallization, the dimensions of the

crystals range from 0.02 μm to a few μm in thickness, and from 0.1 μm to a few tens of μm in length. At very low velocities of rotation, the film on the cathode becomes so thick that the organic layer is not adequate for passivating the lateral surfaces of the whiskers. The author calculates film thickness as a function of depth of immersion, rate of rotation, viscosity and density of solutions. Figures 4; references 4: all Russian.
[92-6610]

UDC 621.762

FRICTION AND WEAR OF A MOLYBDENUM-BORON CARBONITRIDE PAIR AT HIGH TEMPERATURES IN VACUUM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 89-91
manuscript received 12 Apr 79

GURVICH, O. S., DUBOVIK, T. V. and STRUK, L. I., All-Union Scientific Research Institute of Electrothermal Equipment, Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Results are given of tests of friction couples made up of a molybdenum disk rotating against a carbonitride sleeve under a load of 3.3 kgf/cm^2 at a velocity of 0.057 cm/sec in vacuum. The coefficient of friction was determined at 20, 300, 700, 1000, 1300 and 1500° C. As the heat was increased from room temperature to 300° C, the coefficient of friction increased sharply to 0.55, and then fell gradually, reaching a value of 0.2 at 1000° C, which is close to the coefficient of friction of boron nitride on graphite. Wear determined by the weight loss method after rotation for 6.5 hours at 700 and 1300° C was within the limits of measurement of the balance ($\pm$0.01 g). The results of tests at 1500° C showed that these friction couples are suitable for applications in electric vacuum furnaces. Figures 2; references 10: all Russian.
[92-6610]

UDC 621.763:621.396:669.5'71'72

INVESTIGATION OF THE PROCESS OF FAILURE IN REINFORCED MAGNESIUM- AND ALUMINUM-BASE COMPOSITES BY THE METHOD OF SOLUTION ELECTRON MICROSCOPY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 87-90
manuscript submitted 28 May 79

KARPINOS, D. M., KADYROV, V. KH., GORDIYENKO, A. I., MOROZ, V. P. and VERKHOVODOV, P. A., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Composites were produced to form a ductile matrix-ductile fiber product using Mg and Al as the matrices and fibers of Kh14N14M2 steel and boron. Fractographic analysis showed that a ductile matrix-ductile fiber composite (Mg-steel, Al-steel) undergoes ductile failure in the matrix without any changes in the structural morphology of the fracture. Destruction of the fibers is accompanied by necking where with a test temperature increase the processes of plastic flow in the fibers are intensified, which makes it possible to consider the fiber role as a determining factor in the fracture of the entire material. In a composite with a plastic matrix-brittle fiber (Mg-B, Al-B), the matrix fails in a ductile mode while the fibers are brittle. Increasing the test temperauure amplifies the deformation processes of the matrix, subsequently the fibers are crushed and the strength properties of the whole material are lowered. Figures 5; references 6: 3 Russian, 3 Western. [98-6368]

UDC 621.762

HIGH-TEMPERATURE MATERIALS AND COATINGS BASED ON INTERMETALLIDES OF THE NICKEL-ALUMINUM SYSTEM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 33-39 manuscript received 5 Jul 79

PORTNOY, K. I., BUNTUSHKIN, V. P., ZAKHAROV, B. M. and SHAPYROV, A. E., All-Union Scientific-Research Institute of Aviation Materials

[Abstract] Certain physical, mechanical and technological properties are described for powders and cast compositions made from Ni-Al metallides along with the properties of coatings made from high-temperature nickel alloys. Tensile strength of the metallides was lower for the powdered material than the cast counterpart while just the opposite was true for elongation and impact strength. Thermal conductivity and coefficient of thermal expansion was higher for the metallides than for

the corresponding nickel alloy. When compared to WC, Ni_3Al (alloyed) was less wear resistant in the plasma coated form. Results of these tests prompted the conclusion that these materials are well suited for use at high temperatures and in corrosive solutions. Figures 5; references 6: 2 Russian, 4 Western.
[98-6368]

UDC 621.762.4:539.4:536.6.636.2

EFFECT OF ZIRCONIUM CARBIDE AND CARBON ADDITIVES ON THE PHYSICAL AND MECHANICAL PROPERTIES OF ZIRCONIUM DIBORIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 27-29 manuscript received 8 Aug 79

ANDRIYEVSKIY, R. A., KOROLEV, L. A., KLIMENKO, V. V., LANIN, A. G., SPIVAK, I. I. and TAUBIN, I. L., Moscow-Podol'sk

[Abstract] The properties of ZrB_2-ZrC and ZrB_2-C two-phase composites were studied with samples produced by hot compacting of powders. At 2200-2300° C active compaction was observed in the first 20-30 minutes under a pressure of 300-400 kgf/cm^2. The addition of either ZrC or C had little effect on the relative density of the composites although addition of graphite caused a small degree of shrinking which was not surprising since the relative density of the compacted samples was almost 95% without the additives. Addition of ZrC to ZrB_2 did not significantly affect strength. The thermal conductivity of ZrB_2 was lowered when the additives were introduced to form composites. Figures 1; references 9: 7 Russian, 2 Western.
[98-6368]

UDC 621.762

INVESTIGATION OF THE FEATURES OF THE PROCESS OF PRODUCING EXTRUDED NICKEL FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 1-4 manuscript received 13 Mar 79

FEDORCHENKO, I. M., KOSTORNOV, A. G., KIRICHENKO, O. V., CHERNYSHEV, L. I. and PEREPELKIN, A. V., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Grade OP4 carbonyl nickel powders and viscose were used as the initial materials for investigating the process of producing extruded nickel fibers of such small dimension as to be in the whisker class.

After extrusion, the treating process consisted of heating in hydrogen in the interval 20-1400° C for one hour and measuring the mass decrease and volume changes. Mass lost was noted for almost all temperatures, being quite small above 400° C. Loss of binder started at 800° C and the process was completed at 1200° C. The amount of residual carbon in fibers sintered at 1200° C was 0.02-0.03 mass %. Loss of the cellulose binder resulted in shrinkage of the fibers to form an almost nonporous fiber. Figures 5; references 6: all Russian.
[98-6368]

UDC 621.724

LOCATING SECTIONS OF PHYSICAL CONTACT BETWEEN DETONATION COATINGS AND BACKINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 27-29
manuscript received 18 Oct 79

KLIMENKO, V. S., SKADIN, V. G. and ALIFANOV, YU. P., Kiev

[Abstract] A technique is proposed for diffusion annealing of sputtered coatings of nickel on an aluminum substrate to determine the compactness of the zone of contact between coatings and backing. These materials were chosen because of their high interaction activity, which according to preliminary data should lead to intensive formation of solid solutions or chemical compounds as a result of detonation sputtering. Nickel-coated aluminum specimens were annealed at 450-500° C for 5 hours. Examination of the annealed specimens showed diffusion of aluminum into nickel. When the temperature of the coating powder was reduced by diluting the explosive charge with nitrogen, the diffusion coating was irregular in thickness and showed breaks. Increasing the temperature of the coating powder increased the area of physical contact, as shown by the uniformity of the diffusion layer after annealing. The thickness of the diffusion layer, which is apparently the intermetallic compound Ni_2Al_3, was 15 μm, and microhardness varied from 440 to 480 kgf/mm^2 with a load of 10 g on the indentor. The microhardness of the aluminum backing was no greater than 75 kgf/mm^2, and that of the nickel coating did not exceed 150 kgf/mm^2. The differences were still greater for nickel coatings on St.3 steel. In one case a transition layer was formed, and in the other case traces of visible diffusion were observed on the coating-backing interface only at isolated spots. Figures 1; references 6: all Russian.
[121-6610]

UDC 621.762:669.018

INVESTIGATION OF THE PROCESS OF NITRIDING TITANIUM CARBIDE-STEEL MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 30-33
manuscript received 22 May 79

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[Abstract] A study was made on improving the properties of titanium carbide-steel powder materials by chemical heat treatment. Alloys of titanium carbide and Kh6V3M steel containing from 0 to 40% TiC and different amounts of bound carbon in the titanium carbide (18.2%, 19.2%) were nitrided in ammonium at temperatures of 500, 750 and 1020° C and holding times of from 30 to 60 minutes. The initial powdered materials were mixed in a ball mill for 48 hours in alcohol. Pressed alloy specimens were sintered in hydrogen and then in vacuum. It was found that the hardness of the specimens increases with nitriding at temperatures of 500 and 1020° C followed by oil quenching, which can be attributed to diffusion saturation of the steel binder with nitrogen. The nitriding effects are enhanced by extending the time of saturation, reducing the TiC content in the alloys, and reducing the carbon defect of the titanium carbide. The thickness of the nitrided layer was determined by x-ray structural phase analysis and measurement of the microhardness of the steel binder from the nitrided surface toward the center of the specimens. Figures 3; references 6: 5 Russian, 1 Western.
[121-6610]

UDC 620.183.1

ELECTROCHEMICAL DETERMINATION OF THE MICROSTRUCTURE OF THE TRANSITION ZONE IN BIMETALS AND METALLIC COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 54-58
manuscript received after revision 28 Sep 79

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[Abstract] Two solutions are proposed for electrolytic polishing of bimetals and metallic composites: both solutions contain various amounts of n-butyl alcohol, glycerin, perchloric, nitric, picric, tartaric, oxalic and citric acids and aluminum chloride, and in addition the first contains salicylic acid and is based on ethyl alcohol, while the second solution contains succinic acid and is based on methyl alcohol. The

electrolyte based on methanol should be used for polishing combinations of stainless steel and aluminum alloy, while the electrolyte based on ethyl alcohol is recommended for stainless-carbon steel bimetal. The proposed solutions have a working voltage range of 10-60 V. The working voltage is determined experimentally for each pair of metals. After achieving the required quality of polish, the voltage is dropped instantly to zero, and then slowly increased until the microstructure of all components is revealed. The etching voltage is generally 5-10 V.
Figures 2; references 5: all Russian.
[121-6610]

GERMANIUM EXTRACTED FROM COAL AT CHITA HEAT AND POWER PLANT

Moscow IZVESTIYA in Russian No 68, 29 Mar 80 p 6

[Article by A. Kleva, special IZVESTIYA correspondent, Chita: "Metal of the Electronics Age"]

[Text] In operation at the Chita TETs [heat and power plant] is a combined unit for extracting germanium from coal.

Just 20 years ago this semiconductor metal was extracted only from ore. Only countable kilograms were produced in the coke oven batteries of the Donets Coal Basin. Then germanium began to be produced for the first time as a byproduct of the generation of electric power at the Irkutsk TETs-1. It is true that here in burning germanium coal the electric separators trapped a meager amount of the rare earth metal. The rest flew off with the smoke into the atmosphere or was lost in the ashes. The country had to buy the metal abroad.

The USSR Ministry of the Coal Industry Institute of Fossil Fuels was confronted with the problem of developing a technology for more effectively utilizing the coal of the Transbaykal. Research suggested that it was necessary to modify the burning process. The Chita TETs proved to be the closest and most suitable in terms of technology. In a short time in conjunction with scientists was created a plant which made it possible to "retrieve" from a ton of ashes occasionally dozens of kilograms of the metal. The country began to obtain germanium in the required amount.

But new difficulties arose for the people in Chita. The pulverized germanium was trapped by special automatic separators in the form of a set of polyacrylonitrile fireproof bags. Since the coal happened to be supersaturated with sulfur, in the furnaces an acidic environment arose which the synthetic fabric restrained from power for several days. At that time we did not yet manufacture polyacrylonitrile. Innovators solved the problem of neutralizing the sulfuric acid by supplying ammonia to the gaseous medium. Since then each filter bag has lasted more than a year.

With the completion of debugging of the line at the TETs a piece of news arrived: In the Far East had been explored one other deposit of germanium coal which would also arrive here for processing. The head of the boiler section, Ye. Sukharevich, Machinist A. Pisarenko and Separator Operator Yu. Bobylev were involved in developing a system for the combined burning of this fuel of a different nature. Now it is taking place in a unified flow.

The Transbaykal boiler room is utilizing scarce coal to the maximum: It is producing energy and heat from it in addition to germanium. The large-capacity equipment is blocking the way for previously lost precious components. This has also helped in making the city's air basin sanitary. [117-8831]

8831
CSO: 1842

FIANIT -- A NEW TYPE OF SINGLE CRYSTAL

Moscow IZVESTIYA in Russian No 50, 27 Feb 1980 p 2

[Article by Academician N. Belov: "How a 'Vicious Circle' was Broken"]

[Text] Most synthetic crystals inherit the name of their natural analogs -- quartz, ruby, sapphire, emerald, garnet and so on. However, there are also those that have no natural counterparts. Holding an eminent place among these "children of science" is a new group of crystals, the fianits, so named in honor of their birthplace the FIAN [*Fizicheskiy Institut Akademii Nauk* SSSR] (Physics Institute of the Soviet Academy of Sciences). Fianits are solid solutions with a cubic crystal lattice. Their chemical basis is zirconia and hafnia. These oxides are distinguished by extremely high melting points (2,700 and 2,800°C) and by high resistance to the action of acids, alkalis, molten metals and aggressive media.

We have said that fianits are not analogs of natural crystals. There is, of course, baddeleyite -- pure zirconium dioxide. But this crystal cannot compete with fianit, primarily because it is typified by a monoclinic rather than a cubic structure. Recently on the Tazheran alkali massif, which is located near Lake Baikal, a new mineral, tazheranit, was discovered that is comprised of cubic crystals of zirconium dioxide. The discovery of such natural crystals is certainly of great interest. Nonetheless, this mineral cannot compete with fianits either, since the very largest specimens of tazheranit measure no more than 0.5-1.5 millimeter.

The scientists who undertook the creation of the unusual crystals -- the fianits -- were "violating" a prohibitory law which at the time it seemed that nature had imposed on them: it was assumed that it was impossible to synthesize crystals with cubic structure from an oxide melt in the same way that [crystals of] refractory oxides and their compounds are grown (meaning ruby, garnet, alexandrite, rutile, scheelite, etc.).

Of course, if calcium, yttrium and rare earth elements are added to a mixture of zirconia and hafnia, solid solutions of the necessary structure can be obtained under certain conditions. But this is a far cry from synthesis of the crystals themselves.

A glance at the phase diagrams of binary systems might give the impression that synthesis of fianits is only a vain dream. Such diagrams imply that even if we should grow cubic crystals at high temperatures, they would change their structure to tetragonal and simply dissociate as they cooled to room temperature.

This obstacle seemed insurmountable, even though many technically valuable properties of zirconia and hafnia had been known for a long time. Among these are exceptional infusibility and chemical stability. Being excellent thermal insulators, they are capable of forming solid solutions with the most diverse oxides.

Such are the theoretical difficulties standing in the way of creation of the fianits. However, there were also technological difficulties.

Let us imagine one of the enterprises where artificial crystals are produced by growing from the melt, held in a crucible of some refractory material. Usually these are rare metals -- molybdenum, tungsten, or else inert platinum. This crucible containing the melt is heated either in an induction furnace or in a resistance furnace. Crystallization is done by pulling the object on a seed, or by lowering the crucible into a zone with gradually decreasing temperature. This is what is called directional crystallization in which large isolated crystals -- single crystals -- are grown.

What kind of a crucible can withstand an aggressive melt at a temperature of 2,700-2,800°C? As a liquid it interacts readily even with tungsten, the only metal that can withstand such heat. But heat resistance alone would not suffice here, and it was necessary to do away with the metal crucible altogether. The lack of a vessel for melting and crystallizing refractory substances like fianits turned into a serious scientific and technical problem. Until it could be solved, there was no point in thinking about production of a number of new crystals urgently needed by technology and the national economy.

The way out of this "vicious circle" was seen in principle by scientists of many nations. They reasoned: if we can't find a material for the crucible, why not make it out of the same dioxides that go into the melt?

The idea was reasonable. However, the trouble with putting it into practice was that the melt had to be heated from within by the inductive application of energy through the action of radio-frequency currents. And the oxides of zirconium or hafnium are dielectrics.

But in the mid sixties it was learned that when refractory dielectrics melt, there is a sudden increase in electrical conductivity. In other words, the melt ceases to be a dielectric, and can be completely heated by radio-frequency currents. Remarkably, with this original "acquisition"

of electrical conductivity caused by the change in heating temperature of zirconium or hafnium oxides, their unmelted solid shell is changed to an unusual crucible that does not impede induction heating. By putting these new data into practice, scientists worked out an original technique for direct radio-frequency heating and crystallization of refractory dielectrics in a cold container.

The advantage of this method is that a high melting point is no barrier to heating. Of no less importance is the fact that the melt, being in its "native" shell, is spared from contamination. And we should add that the process can be carried out in any gas, including air. To produce crystals by this method, fundamentally new technological facilities were created that are now being used in many plants of our nation. Research by Soviet scientists in this field is at the center of attention of international conferences on crystal growing.

After developing the method of direct radio-frequency heating in a cold container, it was possible to go on to solution of the main problem -- producing refractory crystals based on zirconia and hafnia. Of course, this was preceded by hundreds of experiments on crystallizing melts of different compositions, penetrating studies of processes of phase transformations in the solid state, a minute study of the optical properties of the crystals and so on.

The great achievement of our scientists -- creation of a new class of crystals -- was predetermined by development of the necessary composition of the melt and conditions of its crystallization. We should emphasize the particular property of the crystal structure of fianits, which allows the introduction of the most diverse elements in concentrations up to tens of percent. Among these are rare earth elements, those from the iron group, vanadium, chromium, titanium, scandium and many others. Without disrupting the structure of fianits, these elements impart the most diverse properties, for example changing their density. Another example could be given that illustrates a change in the optical qualities of the crystals: in addition to exceptionally transparent colorless fianits, a totally black crystal has been produced that transmits light only in the infrared region of the spectrum.

A lot could be said about the fianits, but they are remarkable in that no natural or artificial crystals have a similar combination of physical and physicochemical properties. This is what makes fianits so promising for use in different fields of technology. Although they are based on oxides, which are known to be dielectrics, fianits are electrically conductive. And this is very important in the development of a number of devices. Transparency, high refracting capacity and other optical "talents" combined with high mechanical hardness, --these are the valuable properties that determine the high quality of lenses, prisms and other components of this kind. The chemically stable and refractory crystals

can be used to make crucibles for melting aggressive metals and alloys. The fianits are also becoming the ancestors of new high-temperature materials, because they combine with the most "stubborn" partners. Such is the outlook for this new class of crystals developed by Soviet scientists.

For developing and studying the new class of single crystals -- fianits -- a group of scientists and technologists has been nominated for the Lenin Prize. I believe that they are worthy of this high honor. [109-6610]

6610
CSO: 1842

UDC 669.017

EFFECTS OF ANNEALING IN THE $\alpha+\beta$ REGION ON HIGH-TEMPERATURE CREEP OF PSEUDO α-ALLOYS OF TITANIUM

Ordzhonikidze IVUZ, TSVETNAYA METALLURGIYA in Russian No 1, 1980 pp 95-100

KARAKOZEV, E. S., RODIONOV, V. N., and PESHKOV, V. V., Moscow Evening Metallurgical Institute

[Abstract] A study was made of the effect of structural changes occurring in the process of annealing in the $\alpha+\beta$ region on high-temperature creep of pseudo α-alloys of titanium with initial fine-grained structure. Investigated were alloys OT4 of the Ti-Al-Mn (As_3 = 960° C) system and VT20 of the Ti-Al-Zr-Mo-V (As_3 = 990° C) system. It was found that annealing in the $\alpha+\beta$ region has a significant influence on the speed of temperature deformation, where ε depends on two factors: the size of the α-grain and the distribution of the particles of the β-phase. The possible mechanisms of high-temperature deformation of OT4 and VT20 alloys are discussed. Figures 8; references 14: 13 Russian, 1 Western. [97-1015]

UDC 669.295.017.13

THE METASTABLE PHASE COMPOSITION DIAGRAMS OF HARDENED TERNARY TITANIUM ALLOYS ALLOYED BY α- AND β-STABILIZERS

Ordzhonikidze IVUZ, TSVETNAYA METALLURGIYA in Russian No 1, 1980 pp 85-90 manuscript received 7 Jul 78

KOLACHEV, B. A., and BELOV, S. P., Moscow Aviation Technological Institute, Chair of Physical Metallurgy and Hot Metal-Working

[Abstract] In a previous article (IVUZ, TSVETNAYA METALLURGIYA, No 3, 1979) the authors showed that given a phase diagram of the ternary system it is possible to predict the metastable phase composition diagram of hardened alloys of this system. The present article discussed a metastable phase composition diagram of hardened ternary titanium alloys alloyed by α- and β-stabilizers, its projection, isometric cross-sections and vertical sections. Such diagrams might be useful in the selection of the optimum mode of heat treatment and their isometric sections may serve to predict the effects of the hardening and anticipated effects of the aging of hardened alloys. Figures 3; references 5: 4 Russian, 1 Western. [37-1015]

UDC 669.295'71'292:537.533.35

FEATURES OF THE LAMINAR STRUCTURE OF LIGHTLY DOPED PSEUDO-ALPHA TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 563-574 manuscript received 17 Oct 79

NESTEROVA, YE. V., RYBIN, V. V. and OBUKHOVSKIY, V. V.

[Abstract] The transmission electron microscope was used to study the crystallographic characteristics of the laminar structure of two typical pseudo-alpha titanium alloys: 1) Ti-4.7 Al-2V; and 2) the same alloy modified with 0.004 wt.% boron. The study covered determination of the disorientations of adjacent platelets of alpha phase, including platelets belonging to the same and to different colonies, construction of the distribution functions with respect to angles of disorientation, determination of the correlation of relative rotations of platelets within colonies, a detailed study of the particulars of the structure of boundaries and the layers on the boundaries, establishment of the orientational relations between sections of alpha and beta phases situated both within a single colony and in different colonies, and determination of the effect of boron modification on these characteristics. It was found that the orientation difference for plates of alpha phase in the same colony is small ($0\pm2^{\circ}$), and that the vectors of disorientation are compensated so that orientation does not accumulate in a colony as a whole. The vectors of disorientation of adjacent alpha phase colonies correspond to different versions of orientational relation to the initial beta phase. The layers of beta phase belonging to either the same or different colonies are not strongly disoriented relative to one another, and retain the orientation of the initial beta phase. A comparison tf the crystallographic characteristics of both alloys shows that modification with boron affects only the concentration of alpha phase nuclei, and does not alter the general nature of the $\beta \rightarrow \alpha$ phase transition. Figures 7; references 10: 7 Russian 3 Western.
[114-6610]

UDC 669.295:621.785:539.377

INFLUENCE OF ROLLING CONDITIONS ON THE BREAKING TOUGHNESS OF VTZ-1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, 1980 pp 53-55

IVANOV, A. S., TOMSINSKIY, V. S. and SHISHKINA, M. I., Perm' Polytechnical Institute

[Abstract] The structure and properties of titanium alloys are determined by conditions of plastic deformation. In this paper the authors study

the dependence of breaking toughness of VTZ-1 alloy on conditions of deformation. The specimens were rolled in one pass at 820, 950 and 1050° C to a reduction of 40 and 60% with subsequent cooling in water and in air. Standard techniques were used for determining the yield stress at residual deformation of 0.2%, the ultimate strength and the ductility. The breaking toughness parameters (coefficient of stress intensity and critical opening of a crack) were determined on special specimens by a previously developed method. It was found that the highest breaking toughness parameters occur when VTZ-1 alloy is deformed at a temperature close to the point of $(\alpha + \beta) \rightarrow \beta$ transformation with cooling in air where the β-transformed structure has minimum β-grain size with sections of α-phase located along the boundaries of these grains. Figures 1; references 6: 5 Russian, 1 Western. [115-6610]

UDC 669.295'71'6:669'295'71'292:539.4.015

CHARACTERISTICS OF PLASTIC DEFORMATION AND DESTRUCTION OF Ti-Al-Sn AND Ti-Al-V ALLOYS AT LOW TEMPERATURES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 594-601 manuscript received 25 Jul 78

AGEYEV, N. V., RUBINA, YE. B., BABAREKO, A. A., BETSOFEN, S. YA. and BUNIN, L. A., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] An investigation was made of the mechanism of deformation of ternary alloys of titanium with aluminum and tin, and with aluminum and vanadium in the temperature range from 4.2 to 293° K. Tension was applied on an Instron testing machine at a rate of 5 mm/min. The volumetric content of twins was found by studying the microstructure of the specimens on an optical microscope. The mechanism of plastic flow was determined from the change in grain orientation. The width of x-ray diffraction lines was used to evaluate residual microdeformations and calculate internal microstresses. The results showed high inclination to twinning in the Ti-Al-V alloy in contrast to weak twinning in the Ti-Al-Sn alloy. The principal mechanism of deformation of the Ti-Al-V alloy at 20 and 77° K was twinning $\{1\bar{1}23\} \langle 11\bar{2}\bar{2} \rangle$. At room temperature, moderate twinning was accompanied by slip development. Deformation at 4.2° K took place due to twinning $\{11\bar{2}4\} \langle 22\bar{4}\bar{3} \rangle$. Internal stresses in twins were relaxed by secondary twinning along planes $\{10\bar{1}2\}$. Correlation was observed between the mechanical properties of the Ti-Al-V alloy and the fraction of twins, and also the magnitude of internal stresses in the lattice. The nature of fracture of the Ti-Al-Sn and Ti-Al-V alloys was found to depend on the level of the internal stresses that arise under plastic deformation, and on the relaxation mechanism.

Inhibited relaxation in the Ti-Al-V alloy at 20° K produced a faceted-type fracture in contrast to a cellular fracture at 77 and 293° K, and a cellular-faceted fracture at 4.2° K. Figures 5; references 10: 4 Russian, 6 Western.
[114-6610]

UDC 669.295:620.179.18

DETERMINATION OF THE ENERGY OF INTERACTION BETWEEN IMPURITY ATOMS AND DISLOCATIONS IN TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 52-53

BELETSKIY, V. M., MAKSIMYUK, P. A., TABACHNIK, V. I., GRINIK, E. U. and GRITSKEVICH, A. L.

[Abstract] An investigation is made of the way dependence of internal friction of technically pure titanium and VT22 titanium alloy on temperature and amplitude of relative deformation. The internal friction of pure titanium remains constant up to about 300° C, and then begins to increase. Temperature dependence for VT22 alloy is similar, except that the increase in internal friction begins at about 400° C. In addition, the background of internal friction is higher for the alloy. Internal friction in VT22 alloy remains constant with increasing deformation amplitude up to a certain critical value, where internal friction abruptly rises. The amplitude curves for the pure metal are similar, but the background of internal friction is lower. Thus the results show that doping raises the energy of interaction of atoms, which explains the higher breaking strength of VT22 alloy. Figures 2; references 3: all Russian.
[115-6610]

UDC 620.194

CORROSION CRACKING OF AT3, AT6 AND VT14 TITANIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA METERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 36-42 manuscript received 14 Jun 79

VASILENKO, I. I., MELEKHOV, R. K., LEBEDEVA, N. G. and KOVAL', M. V., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] AT3, AT6 and VT14 industrial titanium alloys were subjected to corrosion cracking tests in NaCl (3%) and H_2SO_4 (5-20%) concentrations. After fractographic analysis of the corrosion tests it was determined that in these alloys in NaCl, saturated with 3-3.5 mg/l H_2S, the presence of hydrogen sulfide has little effect on the long-time corrosion of AT3 and AT6 in comparison with corrosion stability in the chloride medium with pH = 1 or 6.5. Cracking is of a ductile nature with insignificant elements of a brittle nature. In VT14 the alpha-phase is responsible for nucleation and propagation of cracks in a brittle fashion since the beta-phase ruptures in a ductile fashion. The high stability of VT14 to sulfuric acid is associated with the features of hydrogen concentration in two-phase alloys. If hydrogen is dissolved in alpha-alloys, only in the alpha-phase, then in two-phase alloys it is concentrated primarily in the beta-phase and at the phase boundaries and this is where corrosion cracks develop. Thus VT14 possesses the best stability to corrosion cracking in either solution than its single-phase counterparts. Figures 6; references 9: 8 Russian, 1 Western.
[104-6368]

UDC 621.791.72

ION-BEAM WELDING OF THE VT6 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 69-70

GABOVICH, M. D., Doctor of Physico-Mathematical Sciences, PROTSENKO, M. N., Candidate of Physico-Mateematical Sciences, PORITSKIY, V. YA., Engineer, GUREVICH, S. M., Doctor of Technical Sciences, ZAMKOV, V. N., Candidate of Technical Sciences, and SHEVELEV, A. D., Engineer

[Abstract] The use of dense ion beams for welding titanium, niobium and vanadium in a vacuum with controlled gas loss from the seam wes tested on the VT6 titanium alloy using an ion flow of up to 1 kilovolt with a specific power of about 10^4 volt/cm^2. Despite low oxygen concentrations that harden titanium, the bonds showed durability equivalent to that of the original metal, apparently as a result of carbon fixed in the seam. X-ray and metallographic examinations of longitudinal and lateral sections showed a lack of cracks or pores, indicating that the process is superior to electronic beam welding. Figures 2; references 3: all Russian.
[96-12,131]

UDC 621.791.72:669.715

LATERAL CONTRACTION AND DEFORMATION IN THE ELECTRON BEAM WELDING OF THE 1201 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 41-43 manuscript initially received 1 Feb 79, in final form 10 Apr 79

BONDAREV, A. A., Candidate of Technical Sciences, and TRETYAK, N. G., Engineer, Electric Welding Institute im. Ye. O. Paton, Academy of Sciencss UkrSSR

[Abstract] Lateral contractions in the weld seam and the heat affected zone were measured in relation to such thermal factors as the thickness of the metal being welded, which varied from 5 mm to 250 mm. Current feed sources of 60 and 120 kilovolts were used, and the welding was performed without bead separation and without clamping, in both the vertical and horizontal planes. Results showed that with an increase in metal thickness, lateral contractions grew on the weld face of the seam, but remained essentially unchanged on the other face. With increased welding aperture, contractions were greater on both sides. Deformation of the collars welded in the test occurred if the metal thickness was below 65 mm. Figures 6; references 3: all Russian.
[96-12,131]

UDC 621.791.052.08

THE CORROSION RESISTANCE OF WELDS 15G2AFD LOW SILICON-CONTENT STEEL IN SEA WATER

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 64-66 manuscript initially received 17 Jan 79, after reworking 3 May 79

LOS', YE. P., and BUT, V. S., Engineers, ASNIS, A. YE., Doctor of Technical Sciences, and IVASHCHENKO, G. A., Candidate of Technical Sciences, Electric Welding Institute, Academy of Sciences UkrSSR

[Abstract] The corrosion resistance of 15G2AFD steel welds on hot-rolled normalized steel welded without preheating was analyzed according to metallographic parameters. The low-silicon steel showed a slightly dispersed ferrite-perlite structure with 10-11 granular size. After welding, the joints were tested for potential variations between the original metal and the welds, in a 3% sodium chloride solution. Corrosion was measured by prophilometer and visually. The tests showed that the 09G2 and 09G2S control steels underwent continuous and irregular corrosion, while the 15G2AFD sample showed lesser, and even, corrosion. The weld seam had the same or less corrosion damage. Figures 1; references 2: both Russian. [96-12,131]

UDC 621.791.052.011:539.3

ANALYSIS OF THERMODEFORMATION PROCESSES IN THE HEAT-AFFECTED ZONE WHEN WELDING HIGH-TEMPERATURE NICKEL ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 11-15 manuscript received 23 Jan 79

EYDEL'SHTEYN, V. YE., engineer, Kuybyshev, YAKUSHIN, B. F., Candidate of Technical Sciences, Moscow, MAKHNENKO, V. I., Corresponding Member of the Ukrainian Academy of Sciences, and VELIKOIVANENKO, YE. A., Candidate of Physical and Mathematical Sciences, Kiev

[Abstract] The thermodeformation process is calculated in the heat-affected zone of a nickel alloy weld, and it is shown how this process depends on the thickness of the metal and on welding conditions. The calculations were done on a Minsk-32 computer by a technique in which the temperature and deformation problems are solved in the cross section of a plate with consideration of the form of edge dressing, assuming simultaneous welding over the entire length of the seam. Data were compared for EP199 high-temperature nickel alloy and grade 25 low-carbon steel. It was found that the combination of low thermal conductivity and retention of mechanical properties at high temperatures disrupts the synchronism of thermal and deformation processes of EP199 alloy in the heat-affected

zone, so that tensile stresses increase at an exceptionally high pace. This results in hot cracks near welds. When parts thicker than 3 mm are welded, the vector of maximum tensile stress in the heat-affected zone for the brittle temperature range is directed along the z-axis, the rate of increase in this deformation being maximum in the middle of the sheet. With increasing thickness, the rate of stretching with respect to the thickness of the sheet changes, passing through a maximum at 10-15 mm. The way that the pace of tensile deformation with respect to plate thickness depends on the running welding energy also is described by a curve with a maximum. However, under conditions of argon-arc welding, the stretching rate of the metal and its inclination to hot cracking in the heat-affected zone increase with decreasing thermal input. When welding EP199 nickel alloy 8-12 mm thick, the inclination to hot crack formation in the heat-affected zone is minimum for a running energy of 9,000-12,000 J/cm. Figures 7; references 10: all Russian. [94-6610]

UDC 621.791.052:620.193

OXIDATION BY HYDROGEN FLUORIDE OF WELDING SEAMS BASED ON NICKEL ALLOYED WITH TITANIUM, CARBON AND SILICON

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 80 pp 9-11

KUZ'MIN, G. S., Candidate of Technical Sciences, and MOCHALOVA, T. F., Candidate of Technical Sciences, Perm Polytechnic Institute

[Abstract] The single compound which nickel forms with hydrogen fluoride, namely nickel fluoride, has a volume increment index $\Delta = 3.17 > 1$ and thus serves as a corrosion inhibiting protective layer on the pure metal. A study was made to determine the effect of three alloying elements (titanium, carbon, silicon) in nickel welding seams on the corrosion resistance of the metal in an atmosphere of gaseous hydrogen fluoride. Each alloying element was added in powder form to CaO-CaF_2-Al_2O_3 ceramic fluxes for welding NP2 nickel strips (10 mm thick) and wires (4 mm in diameter) on an ADS-1000 automatic welder at the rate of 24 m/h (d.c. voltage 30-32 V, current of reverse polarity 520-540 A). Corrosion measurements were performed over a period of 120 h at 550° C under a pressure of 20 atm, with the surface condition, i.e., the nature of the bond to fluoride films as well as the weight loss factor and the degree of intergranular corrosion serving as indicators of the corrosion rate. The latter has been plotted simultaneously as a function of the alloy content and as a function of the test time. These three-dimensional diagrams as well as a 5-zone chemico-structural model (Ni-Ti/Ni/NiF_2/ oxidation/NiF_2) of the surface layer, based on thermodynamic data per taining to selective oxidation reactions, indicate that addition of

0.10-0.30% Ti, 0.10-0.20% C, or 0.10-0.30% Si accelerates formation of the protective film. Rather than reducing the corrosion resistance by causing porosity in this film, these elements tend to deoxidi e the base metal. Figures 4; references 8: all Russian.
[112-2415]

UDC 621.791.4:539.378.3

DIFFUSION WELDING OF ANGLE BRACKETS MADE OF THE VT20 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 80 pp 34-35

MAYDANOV, L. P., engineer, LEVTOVA, K. A., Candidate of Technical Sciences, SIGACHEV, A. N., engineer, KOTEL'NIKOV, A. A., Candidate of Technical Sciences, and MATYUSHKIN, B. A., Candidate of Technical Sciences

[Abstract] Diffusion welding instead of milling after forging increases the metal utilization factor threefold and reduces the labor content in production of ribbed panels and angle brackets made of titanium alloys. A study of this process was made on angle brackets using the medium-strength VT20 titanium alloy (6% Al, 2% Zr, Mo and V added). A special tool was built for this purpose which included a pneumatic clamp consisting of shells stacked on top of a base pad with cavities between them so as to facilitate producing a large set with a small deformation, also a plunger and a chuck for holding the parts, all inside a frame made of a heat risistant alloy and, after assembly held tight by wedges. Before welding in this fixture, the surfaces of parts in contact had been coated with a 0.2-mm-thick ZrO_2 film, to prevent seizing. After welding for 60 min in a CBK vacuum furnace at 960° C (optimum temperature without excessive grain growth) under a pressure of 2.0 kgf/mm^2, the samples were tested for tensile, impact and fatigue strength. Despite the side spread of test data, the clear indication is that diffusion welding yields better strength characteristics, especially a longer endurance under cyclic load, than argon-arc welding and than milling after forging. Fracture was found to occur not in the seam but in the base metal. The process has already been introduced for pilot production of angle brackets. Figures 4.
[112-2415]

UDC 621.791.72.01

PROCESSES OF MELTING OF METAL AND FORMATION OF THE SEAM DURING ELECTRON-BEAM WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79, pp 4-6, 28
manuscript received 19 Mar 79; after revision 31 May 79

LESKOV, G. I., Doctor of Technical Sciences, NESTERENKOV, V. M., ZHIVAGA, L. I., Engineers, Electric Welding Institute imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] A study was made of the heating, melting and evaporation of metal through the height of a channel formed in electron-beam welding. Estimates were made of the magnitudes, points of application and direction of forces and pressures in the channel. This was done by rapidly (within 10^{-3} sec) cutting off the beam of the electron gun, then examining the metal sections. It was found that the deviation of the shape of the anterior wall of the channel from the equilibrium shape depends on the thermophysical properties of the metals being welded and the welding regime. The concentration of power in some projections in the channel was 2.5 times the equilibrium concentration. This high concentration energy caused local melting and evaporation of the anterior wall of the channel. Figures 5; references 5: 3 Russian, 2 Western.
[88-6508]

UDC 621.791.72:669.295

FORMATION OF PORES IN WELDED JOINTS OF VT6 TITANIUM ALLOY MADE BY THE ELECTRON-BEAM METHOD

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79, pp 50-54, 57
manuscript received 16 Jun 78; after rivision 18 Oct 78

ZAMKOV, V. N., Candidate of Technical Sciences, SHEVELEV, A. D., Engineer, Electric Welding Institute imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] An analysis was made of the mechanism of formation of pores in butt-welded seams in VT6 alloy, produced by the electron-beam welding method. Thermodynamic analysis of possible chemical reactions during welding of titanium and experimental data involving taking of gas samples during melting of titanium ingots indicated that if there are no contaminants in the joint, two reactions can occur: production of atomic hydrogen and combination of carbon and oxygen to form carbon monoxide. Photomicrographs of polarizing and welded seams in this alloy are presented. It was concluded that the porosity results from the liberation of atomic hydrogen during melting and crystallization of the metal. It is recommended

that the concentration of hydrogen in the base metal be decreased, that welding be performed at low speeds or that remelting of the seam metal be used to avoid this problem. Figures 7; references 15: 14 Russian, 1 Western.
[88-6508]

UDC 621.791.793

ELECTROSLAG WELDING OF MEDIUM ALUMINUM-MAGNESIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79 pp 43-44, manuscript received 4 Jan 78; after revision 4 Jun 79

SAFONNIKOV, A. N., Candidate of Technical Sciences, ANTONOV, A. V., Engineer, Electric Welding Institute imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] In order to study the weldability of an alloy consisting of aluminum plus 3.8-4.8% Mg by the electroslag method, strips 50 mm thick were welded with a plate-type electrode alloyed with zirconium and magnesium. The composition of the alloy was (%): Mn 0.53, Fe 0.25, Cr 0.065, Si 0.1, Cu 0.075, Zn 0.04, Mg 4.8, remainder -- aluminum. The chemical composition of the flux was (%): KCl 50, LiCl 20, $BaCl_2$ 20, AlF_3 8, LiF 2. Photographs of the macro- and microstructure of the welded seams are presented. The mechanical properties of the joints produced were found to depend on the content of alloy elements and their properties. Zirconium as used in this experiment greatly increased the strength of the welded joint. Figures 1; references 11: 3 Russian, 8 Western.
[88-6508]

GRANULAR METALLURGY DEVELOPMENTS NOTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 33, 9 Feb 80 p 2

[Article by A. Belov, director of the All-Union Scientific Research Institute for Light Alloys: "Through New Technologies"]

[Text] The problem of metal production and use is presently quite acute. This was pointed out to us by the November Plenum of the CPSU Central Committee. In his speech, comrade L. I. Brezhnev named three basic problems. Firstly, basic qualitative changes in metallurgy are carried out too slowly. Secondly, introduction of new technological processes in the key metal-consuming sectors is lagging. Thirdly, there is outright squandering of metal. These three observations also apply to aluminum, which we are concerned with here.

In regard to volume of output, aluminum is the most important of all the nonferrous metals and it is more and more extensively used in the most diverse sectors of the national economy. As can be easily illustrated by its use in agriculture, further development of aluminum production is very advantageous in every respect. Through the use of aluminum, it is possible significantly to expand the construction of hothouses and irrigation systems. Semimanufactures made of aluminum alloys have good technological properties and are not subject to corrosion; this sharply reduces the metal input required for installations as well as labor input.

No less important is the task of reducing the losses in agricultural output during harvesting, processing and storage. Through construction of aluminum graneries, which can quickly be erected under kolkhoz and sovkhoz field conditions, especially in remote and barely accessible regions, it would be possible to preserve for the country a large quantity of grain. There are designs for graneries, which could be assembled in 30 to 50 hours.

Construction of livestock and poultry farms with aluminum elements likewise offers great advantages. Finally, for agricultural products to reach the consumers with minimum losses, it is necessary to establish an extensive network of canneries, especially in the places producing vegetables, fruit,

and dairy and fish products. Such projects likewise require aluminum.

One could name other sectors of the economy, in which aluminum is indispensable. By means of aluminum, it is possible to create new progressive forms of agricultural machinery and specialized transport.

In short, in summing up all the urgent requirements of the agroindustrial complex, one obtains an impressive figure--600,000 tons of aluminum per year. How can we obtain such an increase in the output of the light metal? Scientists have drawn up recommendations and propositions that make it possible to achieve this with minimum input of labor and capital. It is necessary to change the presently accepted principles concerning the siting of enterprises of the aluminum industry.

The raw materials for many of these enterprises have to be transported over long distances. Moreover, these enterprises demand that the output of the power stations that supply them with power remain strictly constant. In addition, they require a lot of heat. But the output of hydroelectric power stations varies in accordance to the river flow. In order to compensate for such fluctuations, the plants must be provided with a supplementary hookup to thermoelectric power stations.

All these problems will be solved, if we apply new principles regarding the siting of enterprises of the aluminum industry.

We feel one should consider establishing a nuclear-metallurgical aluminum complex with an output of 600,000 tons. It should consist of an alumina plant with an ore base, an electrolysis plant, a rolling mill and a nuclear thermoelectric power station--ATETs. This will assure the metallurgists of a constant power supply and of sufficient heat; it will allow significantly to reduce the volume of capital investments, since there is no need here for heat or power transmission lines. There will be none of the losses which are inevitable in the transmission of power over long distances. The transport sector will be freed from hauling millions of tons of raw materials and fuel.

We should speed up the introduction of fundamentally new technological processes. In particular, I would like to talk about granular metallurgy, which despite its resemblance to powder metallurgy is essentially a new technology. In contrast to powders, the grains are obtained through atomization of the metal bath. This helps to insure a high rate of crystallization. The grains are then placed in a form and compacted at a high temperature and pressure. Thus one obtains a highly homogeneous structure.

We completed an important stage in the development of this technology. By means of isostatic compression, high-alloy materials were produced from the grains obtained by the high-speed metal crystallization. By traditional methods, it would have been impossible to obtain these materials. Besides improving the product quality, the new technology allows sharply to lower

metal input and to reduce the mechanical processing in the production of components. At the same time, the demand for fresh charge materials is reduced to one-half; in the long term, it will decrease to approximately one-third.

Through its own efforts, our collecti.. designed and produced industrial test equipment, including furnaces and special equipment for preparing the charges. For producing the grains, the collective has designed centrifugal installations with complex gas-purification systems. There has been developed a system for classifying the powders obtained according to grade and according to their purification by the ionic process.

In many respects, however, the fate of these long-range scientific plans depends on the production of new equipment. Not a single ministry for machine building has as yet started to develop the new machines, furnaces and complex vacuum technology. At best, the ministries can provide individual, separate elements, which must be consolidated by the developers of the process. It goes without saying that such conditions cannot be regarded as normal.
[99-8760]

8760
CSO: 1842

MONOKRISTALL INSTALLATIONS USED IN PLASMA TECHNOLOGY

Moscow MOSKOVSKAYA PRAVDA in Russian No 44, 21 Feb 1980 p 1

[Article by A. Presnyakov]

[Text] There are quite a few sensational events in the variegated history of refractory metals and carbides. The sintering of metal powders into finished items was a landmark of its day. The separate particles of the powders adhered, forming a monolithic mass. Researchers and engineers then turned to the electron beam. This allowed them to produce cast articles from refractory metals. But even this technique was powerless for solving new important design problems.

It was only when researchers had mastered plasma heat of electrically charged gases that new possibilities were opened up for metallurgy. Plasma technology is realized in Monokristall facilities.

In the first models of such units, the initial raw material for melting single crystal ingots was provided by tungsten bars that had been made by sintering from the powder. A series of Monokristall installations has now been developed and produced in which the ingots are melted directly from the tungsten powder. The process has been accelerated, greatly reduced in cost, and simplified.

...An impressive kind of machine can be seen in the shops of the special design office at the Institute of Metallurgy. In a unified complex, this machine combines a plasma melting unit and a system for automatic control, regulation and monitoring.

The melting point of tungsten is 3,380°C. A temperature of 10,000-12,000 degrees Celsius reigns at the heart of the plasma stream. In such a Hell even the "champion of infusibility" cannot hold out; it melts and begins to settle as misty rain on the starter seed crystal. Obeying the law of nature, the tungsten grows layer by layer as a crystal with a single

structure. In accordance with the "design" assigned by the operator, the metal copies the shape of the seed. And before our eyes stands a heavy ingot.

"Under these conditions, powder is the initial raw material, so we can use quite brittle substances from which it has been almost impossible up until now to make workpieces before melting" explained Doctor of Technical Sciences G. S. Burkhanov, one of the developers. "When we use powder, we can easily vary the composition of the charge and produce single crystals of complex compositions made from previously unknown structural materials with predetermined physical and mechanical properties. And the high temperature of the plasma keeps out foreign impurities of metals and alloys. On these installations we can produce large items with various profile shapes, including plates, pipes and bars."

Through electronics, the melting can be done automatically. Electronics also enables on-line operation with computers, which can replace a skilled operator. The entire technological process can be done according to a preset program.

"The interdepartmental committee has given the Monokristall installation high marks" says V. M. Mishin, director of the special design office of the Institute of Metallurgy. "Success has been aided by the close contacts maintained by designers with scientists of the institute labs."

The melting units have been released for installation. The collective of the Institute of Metallurgy has marked out new lines for worthy celebration of V. I. Lenin's 110-th birthday.
[108-6610]

6610
CSO: 1842

RATIONAL USE OF METAL RESOURCES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 61, 13 Mar 80, p 1

[Report on speech given by Academician A. Ishlinskiy, chairman of the All-Union Council of Scientific and Technical Societies]

[Text] The 5th Plenum of VSNTO--All-Union Council of Scientific and Technical Societies took place yesterday in Moscow, at which there was a speech on increasing the role of the scientific and technical societies in the area of searching for reserves of metal and the rational utilization and economy of their use. The chairman of VSNTO, Academician A. Ishlinskiy, said the following on the basic tendencies of this great project:

Among the most important problems brought up for discussion at the November (1979) Plenum of the CPSU Central Committee, Leonid Il'ich Brezhnev particularly singled out the problem of the economical use of metal. "In spite of the huge scale of production of metal," he noted in his talk, "it is not as abundant as it was formerly."

What are the reasons for this deficit? It is not only the increasing growth in the use of metal, but also in how we make use of the supplies we do have. It is no secret that many valuable components of crude ore end up as waste products at the stage of extraction and primary processing. This occurs because nonferrous metals "do not interest" ferrous metallurgy, ferrous metals "do not interest" nonferrous metallurgists. Until now there has not been enough attention paid to the problems of removing the metallic components from the waste products of various production stages. For example, in the making of synthetic fibers slurries are formed which contain up to 40 percent zinc. For chemists they are harmful waste products, whose neutralization and storage require large expenditures. But for metallurgists they could become a valuable raw material.

Analysis shows that the greatest losses of ferrous metals occur during their production. If all the metal arriving in aggregates for smelting of steel is taken as 100 percent, then it turns out that only 72 percent of it ends up in the final product, and about 6 percent is irretrievably lost in the form of oxides and fumes. Searching for solutions which will permit one to reduce these losses is an extensive field of activity for the scientific and technical community.

The use of various methods for strengthening rolled steel products at the manufacturing stage offers great possibilities for metal conservation. However, even thermal strengthening -- a method which does not require large capital outlays -- has not been rapidly introduced: only about 6 percent of rolled products are strengthened by thermal treatment in our metallurgical enterprises.

Moreover, if the critical parts of machines and equipment are made of strengthened rolled steel, then the weight of the structure can be decreased by 20 to 35 percent. Why do we still underutilize these reserves? It seems that herin lies the greatest obstacle -- it relates to the tonnage factor: thermal treatment of metal goods does not increase it, but the human labor expenditures of metallurgists increase. One of the greatest demands for metal is in machine building. Unfortunately, it happens frequently that the metal used in building machines is immeasureably high. Thus, for example, in the "EO-6121" Excavator, produced by Minstroydormash [Ministry of Construction and Road Machinery Manufacture] the weight of the design is 9 tons more than a similar foreign model, and the "KB-405-2" Tower Crane exceeds its counterpart in metal consumption by 26 tons.

The ways of solving this problem are many and varied. However, I will mention only one of them. As is known, the decree adopted last year by the CPSU Central Committee and the USSR Council of Ministers on improving planning and economic procedures envisages periodic expert evaluation of the technical level of goods, machinery and equipment produced. It appears that the scientific and technical community should play the most important role in this important work. Especially since we already have specific experience in this area.

A Provisional Expert Commission of VSNTO studied the possibility of replacing metal by polymer materials in agricultural equipment. Analysis of the designs of "Belarus'" type tractors and "Niva" and "Kolos" type harvesters showed that polymers cannot only compete successfully with metal, but can also have a number of advantages. Their use in place of rolled sheet steel reduces the weight of a design and fuel consumption, increases the useful capacity of an engine, and increases the overall technical efficiency. Such studies must be made in other branches.

The logic of our actual situation is such that even after the machines and equipment go on-line the expenditures of metal for them do not stop -- it is used in making spare parts. It is assumed, for example, that before the "T-130" tractor is written off, just as much metal is used in making spare parts for it as it itself weighs -- about 12 tons!

How can this problem be solved? Many economic managers believe that the production of spare parts must increase in the future. However, such an approach seems inadequate to us. Transition to the system of industrial, company overhaul can be a real counterproposal to it, along with an increase in longevity and reliability of the machines. The sense of this system is simple: whoever makes something repairs it. "AvtoVAZ," the Vil'nyus Fuel Apparatus Plant, has taken this approach. This experience should be closely studied and disseminated: for, according to calculations of specialists, approximately 4 times more effort is expended on repairs in the traditional approach than in company maintenance.

The struggle to economize and efficiently use metal is not a problem which can be solved in one day. It is a constant and tedious program. To carry it on, scientists, engineers and production innovators must mobilize all available methods and means. Many probless become more complex each day. Therefore, they must be solved today on a scientific basis, with consideration of the future prospects.
[118-9424]

9425
CSO: 1842

NEW ROLLING MILL SYSTEM FOR PRODUCING HIGH-PRECISION SHAPES COMMENDED

Moscow IZVESTIYA in Russian No 67, 20 Mar 80 p 3

[Article by P. Polukhin, rector, Moscow Institute of Steel and Alloys, Hero of Socialist Labor, professor and doctor of technical sciences: "Unique Mill"]

[Text] In rolling,metal fluctuations are constantly observed in the dimensions of the starting stock, the rolling temperature and mechanical characteristics. In existing mills with low-rigidity roll stands this results in a broad field of tolerances for the dimensions of rolled shapes. As a result, the quality of products is worsened and much metal is lost.

How to reduce these losses and achieve an increase in finished rolled metal without the additional smelting of steel is an exceedingly important problem. It is precisely along this line that two leading collectives of the country have concentrated their efforts--scientists and designers of the Scientific Research and Planning and Design Institute of Metallurgical Machine Building (VNIIMETMASH) and metallurgists of the Cherepovets Plant imeni the 50th Anniversary of the USSR.

Beginning in the 60's specialists of the institute and plant in close cooperation conducted a combination of basic, theoretical, technological and experimental research on processes of rolling precision shapes and on its basis created a fundamentally new system of rolling mills with high-rigidity roll stands which do not have analogs in world practice.

In the new stands rigidity has been increased eight- to 12-fold as compared with the traditional. This has made it possible to improve considerably the precision of rolled shapes. As the result of a drastic reduction in the weight of the new stands and in their overall dimensions, it has proven possible to install in the spaces between the mill's stands a new automatic regulation system making possible the continuous rolling of a wire rod without strain. This has made it possible to create total stability for the rolling process and has increased the output of suitable metal by 1.5 percent. An improvement in the quality of rolled metal has

been achieved also because of the creation of an efficient system for thermal hardening of the rolled metal.

The new system of mills has been introduced at the Cherepovets Metallurgical Plant. It is made up of a model 250 continuous wire mill, a model 250 continuous light-section rolling mill and a model 350 semi-continuous medium-section rolling mill. This system has undisputed advantages over the existing ones in the technical and economic respects.

During the time of operation, on the new mills of the Cherepovets Metallurgical Plant have been produced more than seven million tons of rolled metal. Furthermore, more than 250,000 tons of metal have been produced in addition without the smelting of steel, and the savings from introducing the new system has equaled about 60 million rubles.

The high scientific and technical significance of this work, submitted by the team at the Cherepovets plant in competition for the Lenin Prize, is characterized by the fact that a fundamentally new trend in the science and technology of rolled metal production has been developed, without having analogs in world practice and reflecting a domestic priority protected by many copyrights and patents.

The problem discussed above was solved successfully under industrial conditions. It must be mentioned that the cardinal retooling of existing high-performance section and wire mills was performed without halting production, within a short period and with minimum capital investment. This was proven possible primarily because of unbroken communication between science and production and a comprehensive approach to solving the problem, both from the viewpoint of the theory of rolling high-quality shapes and of the simplicity of the construction created for roll stands in combination with automatic regulation systems.

The job done by the competitors for the high award has opened up new prospects for the retooling of the country's section mills and will make it possible to gain an annual savings of metal (without the additional smelting of steel) of more than one million tons.

The fundamentally new scientific and technical solutions which have been developed can be used both in section and in other types of mills, for example, in tube mills, cold rolling mills, narrow strip mills, etc. This will improve even more the quality and efficiency of the production of rolled metal and tubes.

A special place in the work project was set aside for drastically reducing the metal content of stands (2.5- to 4.5-fold) and for improving the reliability and operating life of equipment. The reduction in the weight of rolling mill roll stands is important both from the viewpoint of economizing on metal for making them, and of reducing their overall size, relieving foundations, reducing the capacity of load-lifting equipment, as

well as of reducing labor costs in numerous operations of the cycle of manufacturing, assembling and operating the equipment of rolling shops.

The valuable experiment of the Cherepovets Metallurgical Plant and VNII-METMASH is a clear example of the embodiment of the party and government line toward improving the efficiency of metallurgical production, and it deserves approval in every way possible and broad dissemination in the industry. The work project of the creative team of the institute and plant, "Creation of a Fundamentally New System of Mills for Rolling High-Precision Shapes," has been awarded the Lenin Prize.
[117-8831]

8831
CSO: 1842

THE RATIONAL USE OF METAL

Moscow TRUD in Russian No 62, 14 Mar 80 p 2

[Article by I. Melenevskiy]

[Text] Today our country occupies a leading position in the world in the extraction of iron ore, smelting steel and producing rolled products.

They descriptively call metal the bread of industry. It is natural that the more metal we produce the more successful we will be in moving our economy forward. However, is a quantitative expansion of metallurgical products the only possible means? Can't we, along with increasing metal output, widely introduce the newest scientific achievements, making it possible to save metal and replace it with other materials?

A serious and exhaustive conversation has been conducted on the paths of rational utilization and economy of metal which is just now being completed at the Moscow Plenum of the All-Union scientific and technical societies. Those taking part in this work are party workers, ministry and department advisers, advisers of professional union organizations, scientists, production innovators and representatives of the scientific and technical societies. The lecturer, representative of VSNTO, Academician A. YU. ISHLINSKIY, as well as the remaining speakers, noted that the scientific and technical societies introduced a specific contribution in the matter of lowering production metal capacity, using progressive design resolutions and improving technological processes.

An effective system of metal economy has been introduced at enterprises of the Chelyabinsk Oblast by the active participation of the scientific and technical society. The Georgian scientific and technical societies started a massive campaign under the motto "Each council of the Scientific and Technical Society is a headquarters for finding production reserves." Activists of the Scientific and Technical Society (STS) of the Rustav Metallurgical Plant performed much work. With their aid the output of rectangular pipe made of electroslag remelted steel has been mastered at enterprises. However, as underlined at the plenum, many organizations

of STS Ferrous Metallurgy and STS Nonferrous Metallurgy do not take seriously solutions of problems of improving quality and expanding the assortment of metal production and the creation and introduction of new techniques and progressive technology.

Academician and member of the Presidium of the Armenian Republic Council of STS M. V. KAS'YAN, Director of the Section for the Noril'sk Administration of STS Nonferrous Metallurgy, and Laureate of the Lenin Prize YE. N. SUKHANOV spoke at the plenum on problems of more complete extraction of metal from ores and the skillful use of local substitutes for metallic materials.

Causes of irrational use of ferrous metals were subjected to serious examination at the plenum. It turns out that almost 30% of the entire quantity of finished smelting of steel is lost in the process of its production. Many tons of metal are sent to the dump in the form of oxides and wastes, carried out along with the gases. But an even greater loss of metal occurs when it is extracted from ore. In nature as a rule there is no single-mineral raw material. Its division into ores of ferrous and nonferrous metals is very conventional. Quite often this leads to non-agricultural use of the raw material due to departmental politics. For example, at the Kovdor Deposit (Kol'skiy Peninsula) and Darasun (Zabaykal'), where organizations of the Ministry of Ferrous Metals USSR prevail, up to 60% of the valuable components of ferrous metals is extracted but the zinc and lead are not used.

At the plenum it was emphasized that the primary organizations of STS should attempt a more active influence on fulfilling set batches of problems on the rational use and economy of metal.

Chairman of the Leningrad Oblast Council of STS, academician I. A. GLEBOV, Director of the polymer and composite materials section at the Institute of Chemical Physics academician N. S. YENIKOLOPOV, member of the Central Administration of the All-Union Chemical Society imeni D. I. Mendeleyev and Director of the Institute of General and Inorganiz Chemistry imeni N. S. Kurnakov, Academician N. M. ZHAVORONKOV, Chairman of the Committee for the All-Union STS for problems of conservation of the surrounding natural medium Academician B. N. LASKORIN and others talked about means of reducing metal losses.

For example at the Leningrad Trubostal' Plant the lowest coefficient of metal consumption in that branch of industry nas been achieved. Due to the use of minus tolerances as well as introduction of automation of computing pipe weight and introduction of special attachments on the pipe cutting mills, 320 tons of metal was saved in the past year.

One of the effective means of saving is replacing metal with polymer parts. Unfortunately, this branch of industry is still in an incipient state. This year we will produce less than four million tons of polymer parts--several times less than in other developed countries. In fact, a ton of polymer replaces 5-6 tons of metal, which is especially important in the production of pipe. In the entire world a course on replacing metal with polymers in pipe production is being taken, yet we are only slowly mastering this progressive method.

Another example is the use of so-called composite materials. These are not even pure polymers. The latter are the bonding link of traditional materials but impart to them completely new properties. Scientists have developed many valuable composite materials. But until they reach the stage of wide industrial introduction nothing is achieved.

What then is hindering the practical implementation of leading scientific developments in the production? The chairman of the committee of the All-Union STS on problems of the practical use of material reserves, Doctor of Economic Sciences V. P. YEFIMOV told this to the plenum:
--Meanwhile many enterprises are not saving metal. Why in mastering improved, highly accurate and special rolled shapes do the basic expenditures fall on the manufacturer and the advantages occur to the consumer? Obviously the question about changing this system is about to surface. Manufacturers should also receive a definite part of the economy achieved by means of using more modern materials.

It is known that in solving a problem of reducing metal consumption a large role is played by powder metallurgy. Doctor of Technical Sciences V. S. RAKOVSKIY, Chairman of the Commission on Powder Metallurgy of the Committee of the All-Union STS on Problems of the Rational Use of Material Reserves, Chairman of the Council for Primary Organization of STS of the ZIL union, M. M. FISHKIS, Chairman of the Central Administration of STS for the Machine Building Industry and Gereral Director of STS for Metal Cutting Mills, Professor V. S. VASIL'YEV and others spoke about this during their appearances. Manufacturing of machine parts and instruments by powder metallurgy makes it possible to consume 20-33% less metal.

For all the advantages of powder metallurgy it is only taking the first faltering steps. The main cause of this as underlined at the plenum, is that there is no master for the new method. In the Ministry of Ferrous Metallurgy USSR there are specialized plants of powder metallurgy but only a very small percentage of the overall production of this ministry is involved in powder metallurgy.

It was recognized at the plenum as being advantageous to intensify attention of the STS organizations to propagate powder metallurgy and to achieve creation of scientific-production departments of powder metallurgy in the country.

In recent years the STS became more objective in taking on the solving of problems of increasing machine reserves including the struggle with corrosion. This measure is most opportune. Meanwhile, according to the calculations of specialists, costs for repair and counter-corrosion protection amount now to 3-5 percent of the national product. Recently the committee of the All-Union STS for Corrosion Problems and Protection of Metals made a massive review of the objects and locations where special methods of combatting corrosion are required. Much attention to this problem was given by Chairman of the Central Administration of STS for Construction and Deputy Chairman of Gosstroy USSR I. I. ISHCHENKO and Chairman of the Central Administration of STS for Ferrous Metallurgy and Director of the Central Scientific Research Institute for Ferrous Metallurgy N. P. LYAKISHEV.

It was emphasized that up to this point in time there have been no specialized organizations for completing the entire complex of works in many branches on protection of metallic and reinforced concrete constructions from corrosion either in construction or in the process of operating buildings and equipment. The problem of corrosion is an interbranch problem and all organizations of the STS should be involved in its solution.

In the speech of Comrade L. I. BREZHNEV at the November (1979) Plenum of the Central Committee of the Party it was underlined that 1980 "is not only the concluding year of the present five-year plan but is also the basis on which to build the following five-year plan". In securing this base a large role is allocated to metal, without which a further growth of economic capacity of the country is inconceivable. There is no doubt that STS will make it all the more necessary for complete satisfaction of requirements of the national economy for metal.
[110-6368]

6368
CSO: 1842

UDC 669.11:621.785.78

NITRIDE HARDENING OF PURE IRON AND IRON-BASED ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, 1980 pp 5-10

ANASHENKO, V. N. and GULYAYEV, A. P., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The paper generalizes previous research by the authors on the influence of nitrides of vanadium and niobium on the structure and properties of pure iron and steel. The initial carbonyl iron was specially treated to reduce oxygen content, and extra steps were taken to improve degasification during melting of the alloys in a vacuum induction furnace. Chemically pure powders of the nitrides were added to the molten metal in predetermined amounts corresponding to stoichiometric ratios V/N=1 and Nb/N=1. It was found that insoluble nitrides delay grain growth. The effect is more pronounced for the less soluble niobium nitrides. After the nitrides have dissolved in alloys with vanadium nitrides, grain growth takes place by merging. The mechanism of grain growth is migration of boundaries in the case of niobium nitrides. The effect of the nitrides on mechanical properties is due to increased strength of the solid solution, dispersion hardening by nitride precipitation, and reduction of grain size. The ductile-to-brittle transition point is not affected by the strength increase of the solid solution, but is abruptly raised by precipitation hardening, and lowered by reduced grain size. In each specific case the ductile-to-brittle transition point is determined by the combined effect of these factors. Figures 5; references 11: all Russian. [115-6610]

UDC 620.178.2

PHYSICAL FEATURES OF CRACK FORMATION AND GROWTH

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, 1980 pp 10-15

KRISHTAL, M. A. and EPSHTEYN, L. YE.

[Abstract] The article is a continuation of previous research by the authors on the disparity between the theoretical and actual strength of materials, crack development, the influence of structure on crack formation and growth [see M. A. Krishtal, L. Ye. Epshteyn, "Mechanical and Physical Features of Metal Destruction," METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV, No 4, 1978 p 2]. In the present paper the authors consider the problems of applying certain physical concepts to

investigation of crack behavior in loaded materials. The thermodynamic features of the behavior of a stressed solid with cracks and pores are analyzed on the basis of determination of Laplace pressure at high temperature. An examination is made of the formation of pores and cracks resulting from condensation of excess vacancies with heating of the material in slip bands. As the cracks grow by interaction with dislocation pileups, they may become blunter or sharper, retarding or accelerating further movement. Dislocation networks are a barrier to crack growth. An examination is also made of high-speed crack growth with high strain rate deformation of metals. Figures 4; references 9: all Russian. [115-6610]

UDC 669.018.472:620.187:539.382

INFLUENCE OF DEFORMATION ON THE PROPERTIES AND FINE STRUCTURE OF INVAR

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 39-40

GAVRILYUK, S. I. and ZAKHAROV, A. E., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Invars are typified by an anomalously low temperature coefficient of linear expansion. The value of this coefficient depends to a considerable extent on the plastic deformation and heat treatment of the alloy. The authors determine the influence of deformation before heat treatment on the magnetic, mechanical and physical properties and on the fine structure of Invar that contains 35.7% nickel, 0.05% sulfur, 0.010% carbon and 0.20% manganese. Deformation to 30% and 50% before standard heat treatment changes the coefficient of linear expansion, coercive force, hardness and fine structure of the alloy. With increasing deformation, hardness increases from HV 121 to HV 198. After standard heat treatment the hardness reaches the initial value for specimens deformed by 30 and 40%, and exceeds the initial value, reaching HV 140 for specimens deformed by 10%. The coefficient of expansion decreases with increasing degree of reduction, and beginning at a deformation of 30% it remains constant at $0.52 \cdot 10^{-6}$ deg^{-1}. After heat treatment, the coefficient of expansion for specimens deformed by 10% drops to $0.6 \cdot 10^{-6}$ deg^{-1}, and increases by about 20% compared with this figure for specimens deformed by 30% or more. The coercive force increases with deformation, reaching 340 A/m at a deformation of 50%. Heat treatment of specimens deformed by 30 and 50% reduces the coercive force to the value for the undeformed alloy. However, in the case of 10% deformation, heat treatment leaves the coercive force 60% higher than for the undeformed metal. Deformation reduces the region of coherent scattering and increases microdistortions. Heat treatment of the deformed specimens has little influence on the size of the region of coherent scattering, but considerably reduces microdistrotions. Figures 1; references 5: all Russian. [115-6610]

UDC 533.92:535.35

ON THE FAILURE OF METALS DUE TO THE EFFECTS OF LASER RADIATION AND SHOCK-COMPRESSION PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 80 pp 44-49 manuscript received 10 Jan 78

SULTANOV, M. A., and OLEYNIKOV, V. P., Dushanbe

[Abstract] A controlled impulse generator on glass with added neodymium was used with a laser at an initial velocity of as much as 10 joules lasting about 10^{-3} seconds and a dispersion of $5 \cdot 10^{-3}$ rads. Metal destruction was observed visually and by photography using 35-, 75- and 150-mm lenses. Results showed that as the focus of the laser lens was moved away from the metal surface destruction decreased more slowly than when the focal plane of the lens was changed; the shape of the crater formed varied from cylindrical to conical, depending on the location of the focal point. A great number of separate microbeams were noted in the laser plasma of products of destruction. Specific heat physics properties of the metals tested are described. The basic function in breaking down the metals was attributed to the heat effect, with an explosive type of mechanism coming into action near the end of the radiation impulse. Figures 4; references 12: 11 Russian, 1 English.
[95-12131]

UDC 546.823.171

THE FORMATION OF CARBONITRIDE PHASES OF TITANIUM IN HIGH-TEMPERATURE NITROGEN STREAMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980 pp 62-66 manuscript received 21 Apr 79

ZALITE, I. V., PALCHEVSKIS, E. A., GRABIS, YA. P. and MILLER, T. N., Riga

[Abstract] Thermodynamic analysis was conducted of Ti-N-C-H and Ti-O-N-C-H systems and parameters calculated using the minimization of potential method in a temperature range of 1000-5000° K. Results showed that at atmospheric pressure the temperature range of 1800-2700° K was suitable for forming solid solutions with a balance of TiN and TiC, with the carbonitride composition being dependent on N:Ti and C:Ti ratios. With increased pressure the temperature of initial condensation also increased, and the temperature interval for carbonitride formation shifted to 2000-3100° K. Carbonitride formed by a chemical plasma method was found to be much more active than macrodispersion car onitride. Figures 6; references 10: 6 Russian, 3 English, 1 German.
[95-12131]

UDC 535.337+539.26+534.222.2

FINE STRUCTURAL CHANGES OF CERTAIN NONMETALLIC MATERIALS UNDER THE EFFECTS OF WEAK SHOCK WAVES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980
pp 119-123 manuscript received 2 Feb 1979

ARTAMONOV, A. A., ARTAMONOVA, L..N. and GRISHINA, L. D., Volzhskiy

[Abstract] Poly- and monocrystalline samples were studied before and after weak shock waves by X-rays and spectroscopy. Materials tested included sodium nitrate, naphthaline, powder and calcite, and the shock waves were caused by a copper wire explosive for polycrystals and an aluminum foil explosive with monocrystals, with energy ranging from 0.4-1.2 kilojoule. Variations in the strength of the shock wave had no apparent effect on the type II tension lines, but energy and displacement were directly related. A second series of X-rays showed a relaxation of tension and return to the original crystalline structures. The heat produced in the explosions also led to annealing of defects, particularly in substances with low melting points. The number of dislocation phases grew and chemical decomposition increased with the strength of the shock waves. Figures 3; references 12: all Russian.
[95-12131]

UDC 539.16.04.669.017

ON THE EFFECT OF THE PHYSICOCHEMICAL PROPERTIES OF METALS ON THEIR DESTRUCTION DURING LASER RADIATION PROCESSING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980
pp 124-127 manuscript received 19 Aug 77

VERKHOTUROV, A. D., ROSHCHINA, A. I., and DYATEL, V. P., Kiev

[Abstract] Laser processing was conducted in an air and argon mixture at 4--32 joules, with a 12 x 240 mm glass rod activated with neodymium as the working body. Focal length of the lens was from 50 to 70 mm, and beam density was varied from 10^6 to 10^8 watts/cm^2. Results showed a distinction in material removal and depth of penetration between intensities 10^7 watts/cm^2, and 10^7 watts/cm^2. In the first range a constant increase of material being removed was noted as the laser intensity grew. Of the metals tested, vanadium, niobium and tantalum were found to have increased heat conductivity as temperature increased, bringing deeper melting and significant deposits of erosion products on the metal surface. A second group, including hafnium, chromium, molybdenum and tungsten,

had deeper penetration and material loss as the radiation intensity was increased. The third group included titanium and zirconium, which had the lowest temperature parameters. Figures 2; references 4: all Russian. [95-12131]

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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 69

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11 July 1980

USSR REPORT

MATERIALS SCIENCE AND METALLURGY

No. 69

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UDC 669.295.84:548.735.6

GRAIN ORIENTATION OF TITANIUM COATINGS ELECTROLYTICALLY DEPOSITED FROM FLUORIDE MELTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar/Apr 80 pp 64-65 manuscript received 5 Feb 79

BALIKHIN, V. S. and MAKAROV, S. B., Moscow

[Abstract] Research was done to produce titanium coatings with grain orientation favoring high corrosion resistance. The fluoride electrolyte contained NaF:LiF = 1:1, K_2TiF_6 = 10%. The soluble anode was titanium sheet. The cathodes were copper or steel plates. Experiments were done to determine the way that deposition temperature and cathode current density affect the grain orientation of the coatings. It was found that the optimum grain-oriented titanium coatings with plane $(11\bar{2}2)$ parallel to the backing are produced by titanium deposition from fluoride electrolytes at 750° C with low cathode current density. This crystallographic plane is intermediate in corrosion resistance between the best (basal) and worst (pyrimidal) faces of the alpha-titanium crystal lattice. For high denisty and minimum roughness of the deposited coating, a temperature of 750-800° C is recommended for the fluoride electrolytes with a reversing current schedule of D_c = 10 A/cm^2 for 45 sec and D_a = 40 A/dm^2 for 6 sec. Figures 1; references 5: 4 Russian, 1 Western.
[126-6610]

UDC 669.018.95:669.715:669.784'781

ANALYSIS OF MATRIX-FIBER INTERACTION IN FIBER COMPOSITES WITH ALUMINUM MATRIX

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 132-136 manuscript received 21 Apr 79

GUZEY, L. S., KHRITOKHIN, N. A., SEDLYAROVA, V. D. and SOKOLOVSKAYA, Ye. M., Moscow

[Abstract] The influence of alloying on the interaction of molten aluminum alloys with boron and carbon fiber hardeners of aluminum fiber composites is analyzed to improve the bond between the matrix and fiber and to reduce the chemical interaction between them. The width of the reaction zone is measured in aluminum-boron fiber and aluminum alloy-boron fiber composites as a function of temperature and time. Titanium, zirconium or hafnium are used as alloying additives. Also examined is the effect of the simultaneous presence of typical composents of industrial refractory aluminum alloys on the interaction of aluminum and its binary alloys with carbon fibers with silicon, manganese, iron, copper, nickel, magnesium and zinc as additives. Magnesium, zinc, iron and copper retard the interaction with carbon fiber and the first two improve wettability and the last two do not. References 16: 7 Russian, 9 Western.
[124-7872]

UDC 669-494

ON THE ROLE OF INTERFACES OF FIBER COMPOSITE COMPONENTS ON STATIC STRENGTH IN AXIAL STRAIN

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 122-127 manuscript received 10 Nov 79

USTINOV, L. M., Moscow

[Abstract] The hypothesis is demonstrated by theoretical analysis, that the strength of a fiber composite, reinforced with chopped brittle fibers, increases as the strength of the interface of the components increases, and after peaking begins to fall to a minimum, remaining constant as the interface strength continues to increase. The minimum is reached at an intermediate interface strength, which depends on the properties of the components. The validity of the basic conclusions of theory is demonstrated by example of rolled or pressed boraluminum. The aluminum-boron fiber composite with chopped boron fiber is represented as a model, consisting of two brittle fiber bundles, surrounded by a matrix. Strain is applied to the entire system, and the interface strength in one bundle is assumed

to be zero, and maximum in the other, and equal to the strength of the matrix. The strength properties of this model are analyzed and results are found to agree satisfactorily with the basic conclusions of theory. Figures 3; references 16: 10 Russian, 6 Western.
[124-7872]

UDC 669-494

STRESS-STRAIN STATE OF MICROFILAMENT-BASE FIBER COMPOSITE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 116-121 manuscript received 21 Ap 79

CHEBAN, V. G., GORDON, V. A. and BULGARU, O. Ye., Kishinev

[Abstract] The stress-strain state of a metal matrix, reinforced with cast microfilament, is analyzed by a technique developed for composite beams and generalized to the case of a system of parallel reinforcing rods. The microfilament is made by glazing a metal filament, producing a composition with a tri-phase structure. The elastic behavior of the material is analyzed and approximate formulas are derived for determining the elastic and strength properties of the composite as functions of the relative concentration and mechanical properties of all three phases of the composite. The analysis shows that the axial stress in each phase is constant and changes abruptly on boundaries. Vertical and transverse stresses are negligible in comparison with axial stresses, and when the Poisson ratios of all the materials are equal the vertical and transverse stresses vanish, so that all three components of a composite made of an aluminum matrix and glazed steel microfilament under axial strain may be assumed to be in a one-dimension l stress state. References 3: all Russian.
[124-7872]

UDC 669.28+669.296]:548.5

ON THE PRODUCTION OF ANISOTROPIC COMPOSITES BASED ON SYSTEMS INCLUDING A METAL AND A CARBIDE OF A TRANSITION METAL

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 2, Mar/Apr 80 pp 187-189 manuscript received 29 Jan 79

SIDOROVA, T. A., KALASHNIKOV, Ye. V., GUTS, Z. A., ANDREYEV, A. A., KORKIN, I. V. and SMIRNOV, V. V., Leningrad

[Abstract] An examination is made of the structures of cast alloys in the systems Mo-Mo_2-C, Mo-HfC, Mo-TiC, Mo-ZrC and Zr-ZrC over a range of cooling rates from 50 to 10,000 deg/sec. A study was also done on the

feasibility of producing regular structures in these systems by zone melting. The rate of zone displacement (crystallization rate) was varied from 0.01 to 5 mm/sec. The temperature gradient at the crystallization front was constant at 100 deg/cm. Heating was by a single-coil inductor with inside diameter of 12-16 mm. Power supply to the inductor was from a 60 kW rf oscillator at 220 kHz. The results show that regular structures are produced in the Mo-Mo_2C system with zone crystallization at a rate of 0.10 mm/sec, and in the Mo-TiC system at 0.01 mm/sec. No orienting effect was observed in the other systems. Regular structures are "favored" in cast alloys produced at various crystallization rates with unidirectional crystallization. Figures 1; references 3: 1 Russian, 2 Western.
[126-6610]

UDC 621.791.927.5

KINETICS OF HEATING OF HARDENER GRAINS IN THE METAL POOL LURING HARD FACING OF COMPOSITE ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 80 pp 32-35 manuscript received 1 Feb 79; after final revision, 2 Jan 80

YUZVENKO, Yu. A., Doctor of Technical Sciences, BELYY, A. I., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences, UkrSSR

[Abstract] Hard facing of a metal in the welding pool, for the purpose of producing a wear-resistant surface layer, can be made more effective by impregnating the hardener grains to be deposited with a fusible binder alloy and coating them with a protective metal film so as to lower their solubility in the base metal. The feasibility of this depends on the kinetics of the thermal processes in the pool and on the concentration of hardener grains, both factors determining the interaction between the components. The specific example here is a very large pool of molten steel, initially at a high temperature uniform throughout the volume and then cooled while small spherical grains of tungsten carbide with a nickel coating at room temperature are dropped into it. An analysis based on the applicable equation of heat balance and the Fourier equation of heat conduction reveals that, depending on the order in which the melting points of the component substances decrease, the coating can be beneficial inasmuch as it lowers both the peak contact temperature and the solubility of hardener grains. The coating also lowers the maximum safe concentration of hardener grains which, if necessary for improving the wear resistance of the layer, can be raised by other means. Figures 6; references 2: both Russian.
[135-2415]

UDC 529.4

EFFECT OF RESIDUAL STRESSES ON FRACTURE OF BINARY COMPOSITE MATERIALS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 53-57 manuscript received 28 Feb 77

MALAFEYEV, A. S., TRU H, I. I. and BEREZHNITSKIY, L. T., Physico-Mechanical Institute, Academy of Sciences, UkrSSR, L'vov

[Abstract] A temperature change causes strains in a composite material which are proportional to the thermal expansion coefficients of the component substances. When these strains do not decrease due to plastic flow, then brittle fracture can result. Accordingly, residual stresses must be taken into account in an evaluation of the strength of composite materials with cracks. Here the problem is treated analytically in the case of a composite material consisting of a binder matrix and a reinforcement inclusion. The concentration of inclusion elements is sufficiently low to make interaction between them negligible. The bond of inclusion elements to the matrix is sufficiently strong to make them deform simultaneously with the latter. The physico-mechanical properties of both components are assumed to be independent of the temperature within the range of temperature changes. On this basis calculations are made of the stress distribution in a circular inclusion inside an infinitely large isotropic and elastic plane, with a straight diametrical crack inside the inclusion, under a thermal load compounded by either uniaxial transverse or equibiaxial orthogonal tension. Analogous calculations are made for the case of a crack extending into the binder matrix. The results indicate a local effect of inclusion elements, of almost the same magnitude under uniaxial and biaxial tension. Depending on whether $(\alpha_{mt} - \alpha_{it})\,\Delta t$ is positive or negative (α_{mt}, α_{it} denoting the coefficients of linear thermal expansion of the matrix material and the inclusion respectively, Δt denoting the temperature change), residual stresses will correspondingly increase or decrease the strength of the composite. Figures 1; references 6: 5 Russian and 1 Western.
[132-2415]

UDC 621.793

USE OF COMPOSITE CERAMIC-ALUMINUM/NICKEL POWDERS FOR COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 24-28
manuscript received 26 Dec 78

NOVIKOV, N. N., PUSTOTINA, S. R., SOLOV'YEV, B. M., PISKAREVA, N. M. and TOLOK, V. K., Odessa Technological Institute of the Food Industry

[Abstract] A new composite material has been proposed for spraying on ceramic substrates of alumina or zirconia so as to ensure adequate chemical interaction and, as a result, a high bond strength of such coatings on metallic articles. Particles of this material consisting of aluminum and nickel are deposited with a plasma (Ar:Ne = 1:1) jet and then quenched in water to form a double-layer shell. With the nickel layer underneath, a smooth coating film is formed on a wettable oxide surface. With the aluminum layer underneath, its continuity is broken up by nickel dispersing in it, and an agglomerate structure of droplets with high surface tension is formed. In either case, according to x-ray phase analysis with a DRON-0.5 diffractometer and a CuK source, the most complete formation of the Ni_3Al intermetallic compound and maximum utilization of the exothermic effect are achieved with an Al:Ni = 1:3 powder mixture. The bond strength of such 0.1-0.2-mm-thick coatings was found to reach 300-400 kgf/cm^2, and to reach 500 kgf/cm^2 with a chemically deposited nickel undercoating. The porosity was lower in Al_2O_3+Al+Ni than in Al_2O_3+Ni+Al coatings. Figures 3; references 7: all Russian.
[75-2415]

UDC 620.171.5:621.822.5:669.018.95

STRESS DISTRIBUTION IN COMPOSITE ANTIFRICTION MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 54-59
manuscript received 6 Dec 78

ZABOLOTNYY, L. V., Institute of Problems of Material Science, Academy of Sciences, UkrSSR

[Abstract] An optical polarization method has been developed at the Institute of Problems of Material Science jointly with the Chair of Elasticity Theory at the Kiev State University imeni T. G. Shevchenko for analyzing the stress distribution in structurally anisotropic materials. This method, using a GMV-57 photoelastimeter (made in Czechoslovakia), was employed in a study of an antifriction compound consisting of epoxy resin and polyamide (100:140 or 100:150). This compound was heated to 70° C, deaerated at this temperature for 5 min, and then poured into a

mold together with inclusions of a high-elasticity polymer. The mold consisted of metal plates with an organosilicon fluid coating. Ioschrome patterns under variously applied loads, correlated with measurements of principal stresses in models containing single inclusions only, indicate that a spheroidal or ellipsoidal shape of inclusions yields the optimum stress distribution under any load. Wear-resistant solid inclusions with a diameter larger than that of the contact area are safer, carrying a much smaller load than the matrix, and an adequately wide spacing of such inclusions improves the fatigue strength of the composite material. Figures 5; references 5: all Russian.
[75-2415]

UDC 539.3:678.5.06

DYNAMICS OF FLIGHT VEHICLE COMPONENTS MADE OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979
pp 1042-1047 manuscript received 17 May 79

VOL'MIR, A. S., and DEDIK, Ye. V., Moscow

[Abstract] The dynamic characteristics of intricately shaped airfoils made of composite materials are investigated. The airfoils are simulated with an orthotropic plate of variable rigidity. The finite-difference method is applied on satisfying varied boundary conditions by introducing the concept of the plate of zero rigidity and mass. The problem of determining the frequencies and forms of intrinsic vibrations is solved with the aid of a computer. The effect of the wing aspect ratio, and the mass and rigidity distribution on the dynamic characteristics of the composite-material airfoil is investigated. The convergence of the method was verified for a model problem--the case of a triangular isotropic plate of fixed thickness. For practical calculations a grid with 30-40 nodes is sufficient. Figures 4; references 6: 3 Russian, 3 Western.
[80-1386]

UDC 620.173:678.067.5

FEATURES OF THE COMPRESSIVE TESTING OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979 pp 1111-1118
manuscript received 7 May 79

ZHIGUN, I. G., POLYAKOV, V. A. and MIKHAYLOV, V. V., Riga, Institute of Mechanics of Polymers, Latvian SSR Academy of Sciences

[Abstract] Normally, reliable information on the compressive strength of composites is difficult to obtain owing to the high degree of anisotropy of their elastic characteristics and to their low shear strength. Hence a broad variety of techniques of the compressive testing of composites is employed, resulting in a broad scatter of experimental findings. In this connection, three different techniques of compressive loading of specimens are analyzed: normal loading of the principal surfaces; normal and tangential loading of lateral surfaces; and combined normal loading of frontal surfaces and normal and tangential loading of lateral surfaces. On the basis of an analysis of stress distribution in the specimens, the first of these techniques is found to be deficient in view of the high stress concentrations at the lateral surfaces. The parameters of specimens are selected according to the conditions of their stability until the exhaustion of loadbearing strength. The effect of loading method and dimensions of the specimen on its compressive strength in compressive testing of carbon- and boron-plastics is investigated. Recommendations for selecting the shape and dimensions of specimens of modern composite materials with the object of determining stable values of their strength are presented. Figures 3; references 10: 5 Russian, 5 Western.
[80-1386]

UDC 536.2:678.5.06

ANALYSIS OF THE THERMAL RESISTANCE OF COMPOSITE STRUCTURAL ELEMENTS MADE OF HEAT INSULATING MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, 1979 pp 1048-1053
manuscript received 26 Mar 79

ZARICHNYAK, Yu. P. and MURATOVE, B. L., Leningrad Institute of Precision Mechanics and Optics

[Abstract] A method for computing the thermal resistance of heat-insulating wall panels made of composite materials is presented. Panels with honeycomb and corrugated types of partitions are considered. The method is based on the analysis of the temperature field in structural elements with heat flux directed at right angles to the panel's plane. The

transport of thermal energy across the composite wall owing to thermal conductivity, radiation, and convection is considered. Formulas for estimating the effective thermal conductivity of discrete panel cells are derived. The theoretical findings are compared with experimental data on panels of various geometry in the presence of temperatures ranging from -40 to 90° C, and it is shown that the proposed formulas and models make it possible to design composite panels with desired heat insulating characteristics. It is also shown that structural elements made of composites reinforced in various ways with glass plastics are extremely promising as materials for developing lightweight structures for various purposes. Figures 7; references 6: all Russian.
[80-1386]

EFFORTS TO REDUCE CORROSION THROUGH THE USE OF PROTECTIVE COATINGS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 70, 25 Mar 80 p 2

[Article by S. Bukharin, Special Correspondent, Slavyansk-Zhdanov-Moscow]

[Text] A discussion about engineering, which can help to solve one of the most urgent problems--reducing the losses of ferrous rolled products--can start from the statements of scientists. Academician Ya. M. KOLOTYRKIN said: "Direct losses due to corrosion amount to approximately 13-14 billion rubles per year. But direct losses are only a part of the total losses and are not the main cause." Academician B. Ye. PATON stated: "In a year, as the result of corrosion, we lose 15 million tons of steel. A gigantic metallurgical combine works only on rust." Academician A. I. TSELIKOV added: "If we are to further prevent disruption in the production of rolling and protect rolled products from corrosion, rust must be halted or it will consume even more. Rolled products should be protected immediately as it comes from the metallurgical combines and plants. Today we have an adequate technical stockpile in order to furnish protective coatings over a wide industrial base. This is primarily related to sheet rolling, in which the branches of machine building and the construction industry are testing for a large need."

The scientific and technical stockpile, about which Academician A. I. TSELIKOV, Director of VNII metmash [All-Union Scientific Research Institute of Metallurgical Machine Building] talked, can be seen in the city of Slavyansk in the Donetsk Oblast. Here, several years ago, an affiliate of VNIImetmash developed protective coating units for all forms of ferrous rolled products. For instance, take steel strip and wire. At the experimental plant of the affiliate the coworkers displayed a working model of a future industrial unit where during a continuous process the strip and wire undergo electrolytic etching, are cleaned and then treated on the electrolytic tinning or chromium plating units. The finished product is then suitable for shipment.

Even now new units are developed in miniature and their working processes are adjusted and presented to the designers, who can then proceed to design industrial engineering samples. But what can these units do? The Moscow

Serp i Molot Plant has been put into operation a line for applying a protective coating to thin steel strip, and the Zhdanov Metallurgical Plant imeni Il'ich has installed a tendem AGTs-2U unit for hot zinc plating thin cold-rolled sheet which works wonderfully. True, the units operating at the Zhdanov Metallurgical Plant are still not the last word in engineering. While 200-240 grams of zinc are used per square meter of rolling stock in the hot method of applying a coating, the electrolytic zinc plating process requires only one-fifth the amount of zinc for the same area.

If we can say that protected metal lasts several times longer than unprotected metal, then the introduction of this new engineering at ferrous metal enterprises will yield an economic effect to the national economy the extent of which would be difficult to estimate. It was not by accident then that in the approved programs of the State Committee USSR for Science and Technology (SCST) the development and industrial introduction of protective coating units is being provided to the branches.

What of the directors of the Ministry of Ferrous Metallurgy USSR? Did they seize the developed methods and begin to widely introduce the new technology at enterprises?

The unit for hot zinc and aluminum plating, the AGTsA-1700, according to the SCST plan should have begun producing in 1978. Associates of the affiliate of VNIImetmash completed technical design of the unit but it won't go into mass production until 1981, 1982 or 1983 and the end of the transfer period can't be seen on the horizon. The same fate overtook the AGTs-2000 unit, a complex of continuous units for electrolytic zinc plating, a unit for electrolytic tinning of sheet and chromium plating of sheet and units for lead plating strip and polymer coatings. A powerful unit for electrolytic zinc plating, the ATETs-2000, is scheduled to be put into operation in 1985 at the Karaganda Metallurgical Combine. The investigation and checking of operating modes of this unit must be started this year but the deal has been frozen because the Karaganda Combine refused to award a contract for equipment design.

"Such cases are not unique in our practice," says V. I. DUNAYEVSKIY, Director of the institute affiliate. We created a good technical stockpile for production of domestic units for protective coatings, but they are not being put into industry.

The same Slavyansk affiliate of VNIImetmash, by the order of the Ministry of Ferrous Metallurgy, together with the Dnepropetrovsk Institute of Ferrous Metallurgy, carried out plans for reconstruction of the 2500 and 1700 cold rolling mills for the Magnitogorsk Combine and the Cherepovets and Zhdanov Metallurgical Plants. A new method for rolling large rolls was the basis of the designs. On the merits of the designs it can be said that the productivity of the 2500 mill would rise by 62.5% and that of the 1700--by 80%. The equipment can almost be placed in existing

areas. This overequipping will provide a rise in production by 2.6 million tons per year, which is equivalent to the introduction of the cold rolling mill built at the Novolipets Metallurgical Plant. However, the Ministry of Ferrous Metallurgy preferred to freeze these designs and units for protective coatings.

Our country has achieved the greatest position in the world in the smelting of iron and steel and the processing of rolled shapes. Rolled sheet production is even greater. And at the same time, when labor has already been expended in the mining of ore and production of metal for the three first conversions, we cannot rationally use the production, since too much of it is disappearing irrevocably to corrosion. It approaches the fourth conversion. Where is the logic?

We will offer a word to the chief of the technical administration of the Ministry of Ferrous Metallurgy USSR, V. V. LEMPITSKIY: "the fourth conversion is the Achilles' heel of our branch."

And then the appearance of this "heel" was explained. No, the lack of capital expenditures is not the reason for the lag in the fourth conversion. For each five-year plan ferrous metallurgy received capital for its development, but it was applied to the same production which gave rise to the growth of smelted and rolled tons of metal. That is to say, to perceptibly improve the operating indicators of the branch enterprises. For example, hot rolling mills. They are cheaper "cold" mills, and the labor expenditures are less on them. What sense was there for the plants and combines to introduce expensive equipment which only reprocessed the already rolled metal? And to order more protective coating units from the machine builders? In fact this was just another indication to start into the conversion of finished production and to lower the indicators by not producing payments in tons from capital expenditures.

Indeed, is this the logic as the result of which millions of tons of rolled products and pipe rust? It is possible, for the sake of "their" indicators, that the government interests were relegated to the background?

Not without interest is the opinion of the Deputy Chief of the Division for Heavy Transportation and Highway Construction Machine Building of Gosplan USSR, I. S. Reves. He explained that the capacities of plants under the Ministry of Heavy Machine Building are from year to year encumbered only with the manufacture of equipment for the three first conversions of producing protective coating units. It is necessary, finally to develop a specialized machine building base for the fourth conversion, but there are no capital expenditures available. For example, in Slavyansk, construction of an experimental plant for the affiliate of VNIImetmash has begun and reconstruction of the Slavyansk Heavy Machine Building Plant is proceeding. Both projects are situated next to each other and could be used as that specialized base for producing protective

coating units. However, the work here was delayed excessively due to the fact that it is weakly financed. Gosplan is not releasing capital. Two of its divisions, found under one roof, could solve the problem, transfer a portion of the capital for creating a base and organize production of domestic engineering for the fourth conversion. But no, the two divisions cannot find a common language.

"Machine builders do not know how to make good protective coating units" says A. F. MINAYEV, Chief of Gosplan's Ferrous Metallurgy Division.

The conviction, being softly spoken is invalid.

We can be proud of the fact that our country takes first place in the production of steel and rolled products. But it is absurd if millions of tons of this production are consumed by ordinary corrosion, causing a billion losses annually. Development of ferrous metallurgy requires a qualitative change. It is not possible to forget comrade L. I. BREZHNEV's statement at the 25th Congress of the CPSU: "...in the final analysis it is not steel but parts made from it that are needed by the consumer. And he receives them only when there is a wide assortment of rolled products of the proper quality of metal..."
[123-6368]

6368
CSO: 1842

UDC 620.197.3

CORROSION WEAR OF ShKh15 STEEL IN AQUEOUS SOLUTIONS OF POLYETHYLENE GLYCOL AND GLYCEROL WITH INORGANIC INHIBITORS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 137-140
menuscript received 18 Jun 79

TOLSTAYA, M. A., KROPACHEV, V. S. and SHILOVSKAYA, M. YE., Central Scientific Research Institute of Ferrous Metallurgy

[Abstract] The corrosion-electrochemical behavior of unquenched ShKh15 steel was studied under friction conditions in nonflammable hydraulic fluids (polyethylene glycol and glycerol in water) in the presence of inorganic inhibitors. The study showed that oxo anions $Cr_2O_7^{2-}$, HPO_4^{2-} and NO_2^- have a considerable effect on corrosion wear of ShKh15 steel in polyethylene glycol and glycerol. Bichromates (chromates) and phosphates in combination with some organic inhibitors can be recommended for suppressing the corrosive action of these fluids. The organic additives extend the protective range of the inorganic inhibitors. Soviet-produced salts of chromic and phosphoric acids are inexpensive and readily available. Figures 3; references 9: 8 Russian and 1 Western.
[128-6610]

UDC 620.193

CORROSION OF ALUMINUM ALLOYS IN THE BLACK SEA AT VARIOUS DEPTHS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 156-158
manuscript received 15 Dec 78

ULANOVSKIY, I. B., Academy of Sciences USSR, Institute of Oceanology, Southern Division

[Abstract] Six aluminum alloys were tested for corrosion at depths ranging from 7 to 80 m in the Black Sea. Test duration was 21 months. The rate of corrosion increases from 0.0031-0.0033 $g/m^2 \cdot hr$ at a depth of 7 m to 0.0046-0.0057 $g/m^2 \cdot hr$ at 80 m, with losses as high as 0.0067 $g/m^2 \cdot hr$ in isolated instances. An analysis of hydrophysical and hydrochemical data for the test region and the results of laboratory tests made it possible to rule out depth variations of oxygen concentration, pH, temperature and flowrate as factors leading to the depth behavior of aluminum corrosion. The main factor was shown to be the variation in silicic acid concentration, which increases with depth due to decreasing photosynthetic activity. Figures 1; references 9: all Russian.
[128-6610]

UDC 620.193.01

INVESTIGATION OF THE MECHANISM OF CORROSION CRACKING OF TITANIUM ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 120-125
manuscript received 31 Jul 78

MARICHEV, V. A., ROZENFEL'D, I. L. and LUNIN, V. V., Academy of Sciences USSR, Institute of Physical Chemistry

[Abstract] A study was done on the influence of cathodic polarization to -1.3V on the growth rate of a crack in corrosion cracking of titanuum alloys at room temperature. Specimens of VT3-1, VT5, VT15, VT4 and VT20 were studied in solutions of NaCl and NaF, and also with delayed destruction in air. The technique used for determining the mechanism of cracking corrosion involved studying the influence of cathodic polarization on crack growth as a function of the initial rate of growth at the corrosion potential. This approach was developed previously for high-strength steel. Titanium alloys typically show a combination of two fundamentally different mechanisms of subcritical crack growth: one produces crack growth as the metal interacts with the corrosive medium (the mechanism of corrosion cracking), and the other acts in the absence of a corrosive medium. The principal mechanism of corrosion cracking of alloys of VT4, VT3-1, VT20 and VT15 in a solution of NaCl, and VT3-1 in a solution of NaF, is anodic dissolution of the metal at the tip of the crack. In this case, crack growth can be considerably delayed or totally stopped by cathodic polarization. The principal mechanism of cracking corrosion of VT4 alloy in a solution of NaF is hydrogen embrittlement in which cathodic polarization accelerates crack growth. Figures 3; references 15: 2 Russian, 13 Western.
[128-6610]

UDC 620.193.4

CORROSION BEHAVIOR OF AD1-V SHEET COMPOSITE IN VARIOUS MEDIA

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 126-132
manuscript received 18 Jun 79

TOLSTAYA, M. A., MANUYLOV, V. F., GRYUNVAL'D, M. P., MUKHINA, M. G. and KEMKHADZE, V. S., Moscow Aviation Technological Institute

[Abstract] A corrosion-electrochemical study was made of the Soviet AD1-V boroaluminum composite produced by hot rolling. Corrosive media were selected to simulate flight conditions of aircraft components: air at 100% relative humidity, tap water, a 3% solution of sea water with 0.1% H_2O_2 added, and a 3% solution of NaCl acidified to a pH of 4 by HCl.

It was found that the AD1-V composite with a volumetric fraction of boron fiber of 20 and 25% can be considered corrosion-resistant under subtropical humid conditions close to the sea. Slight damage was observed under these conditions on AD1-V (30%), but the material was not destroyed after a year of holding under these conditions. AD1-V can be considered completely stable in rain or river water, especially when the ends of sheets are protected. Sea water is agressive to this material, even when only the flat side of the boroaluminum sheet is contacted, and corrosion resistance drops sharply with increasing boron fiber content. In peeling corrosion, the major factor is the action of galvanic cells formed by the AD1 aluminum matrix and the boron fibers. Contact current is appreciable and persistent only when the aluminum matrix is active in chloride-enriched media. A reduction of pH activates the aluminum and intensifies peeling corrosion. Subsurface corrosion develops due to deep pitting and bubbling of the foil layers in chloride-enriched media. Figures 4; references 10: 7 Russian, 3 Western.
[128-6610]

UDC 620.193

INVESTIGATION OF HYDROGENATION AND STABILITY OF TITANIUM WITH CATHODIC POLARIZATION IN A SODIUM CHLORIDE SOLUTION

Moscow ZASHCHITA METALLOV in Russian Vol 16, No 2, Mar/Apr 80 pp 113-119
manuscript received 12 Feb 79, after revision 16 Jul 79

TOMASHOV, N. D., MODESTOVA, V. N., YAKUBENKO, A. R., YEVTUSHENKO, I. V., VLASOVA, YE. S., BAGAYEV, S. P., IL'IN, M. I. and BORISOVA, YE. A.

[Abstract] The stability, hydrogenation and mechanism of destruction of VT1-0 titanium specimens were studied at a cathodic current density of 3000 A/m^2 in a solution of 0.5 n. sodium chloride. The studies were done on hot-rolled bar stock, forged, stamped and rolled bars, hot-rolled pipe, hot-rolled annealed sheet and forged castings. A relation was found between metal structure and corrosion resistance. It was found that destruction of the hydride layer is by brittle laminar fracture. The outer layer of electrolytically formed hydride has the composition of TiH_2. The high internal stresses that destroy this layer are due to the different specific volumes of the hydride and titanium. Titanium becomes more resistant to cathodic corrosion as grain size decreases and metal structure becomes more perfect with elimination of martensite structure, improvement of grain uniformity, reduction in the number of twins and elimination of special orientation. No clear relation could be established between corrosion resistance of titanium and impurity content. Cathodic hydrogenation of titanium is considerably reduced by oxidizing the titanium in the solution with periodic interruption of the current. Figures 4; references 9: 4 Russian, 5 Western.
[128-6610]

UDC 620.178.3+620.18

RESISTANCE TO THERMAL FATIGUE OF HEAT RESISTANT ALLOYS WITH PROTECTIVE COATING

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 59-63 manuscript recieved 7 May 79

BOKSHTEYN, S. Z., BYCHKOV, N. G., DUL'NEV, R. A., ZAYTSEV, G. N., OL'SHANSKAYA, E. YA. and RYBINA, T. V., Central Scientific Research Institute of Aircraft Engine Building imeni P. I. Baranov

[Abstract] Blades of gas turbines are calorized for protection against corrosion and erosion in a gas stream in an atomsphere of combustion products. However, such a coating also reduces the plasticity of the surface layer and has been found to reduce, under sufficiently high static loads, the fatigue resistance of ZhS6KP heat resistant steel under cyclic thermomechanical loads. A study was made to determine the effect of various coatings on ZhS6U heat resistant steel under a deformation of 0.6-3% and 100 $\rightleftarrows$ 950° C temperature cycles with holding for 1.5 min at 950° C. The most effective crack inhibitor under these conditions was the NiCoCrAlY coating (50-80 μm thick) with an $\alpha+\beta$ phase structure. With Ni-15Al-35Cr-Y and CoCrAlY coatings, cracks were found to propagate radially into the base metal and to shorten the life most appreciably. In air at a large deformation ($>0.8\%$) the life of specimens decreased by 30-50% and at a small deformation ($<0.6\%$) after 10^3 cycles the life of specimens remained the same with or without coating. Figures 5; references 8: 3 Russian, 5 Western.
[139-2415]

UDC 620.194

EFFECT OF CHEMICO-THERMAL TREATMENT ON THE RESISTANCE OF WELDED TITANIUM JOINTS IN CORROSIVE MEDIA

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 118-119 manuscript received 4 Jun 79

VOVK, S. T., "Khlorvinil" Kaluga Industrial Association

[Abstract] Pure grade VT1-0 titanium is used for equipment in the "Khlorvinil" Kaluga Industrial Association production plants. Its corrosion resistance in aggressive media is one order of magnitude higher than that of structural carbon and stainless steels. Oxidation and molybdenization of welded titanium joints have been found to be completely effective, cementation to be only partially effective, and plating or varnishing to be not effective at all in protecting welded titanium

joints against corrosive wear in kainitic lyes (pH = 4.3, 60-115° C), magnesium-chloride lyes (pH = 2.3-4.8, 65-90° C), hypochlorite solution (40-50° C), and in HCl vapor + $MgCl_2$ aerosol mixtures (pH = 3-4.5, 100° C). References 4: all Russian.
[132-2415]

CHEREPOVETS BLAST FURNACE CONTROVERSY

Moscow STROITEL'NAYA GAZETA in Russian No 39, 30 Mar 80 p 2

[Article by G. Savel'yev, candidate of technical sciences and senior science staff member of the Central Scientific Research and Experimental Design Institute for the Organization, Mechanization and Technical Assistance of Construction: "What Should a Blast Furnace Be?"]

[Text] The Cherepovets metallurgical plant has exceptionally great significance for the further growth of the country's output of ferrous metals. On the plant's territory is located a second high-output plant with a complete metallurgical cycle: a blast furnace, an oxygen-blown converter and a "2000" mill.

Unfortunately, the development of the second plant began with the "tail end." The first facility to begin production was the last link in the technological chain--the mill. This leads to great non-productive losses. It is sufficient to say that the mill is being fed with imported slabs, each of which costs 14 rubles per ton more than the future Cherepovets slabs which the oxygen-blown converter should produce. However, the construction of the latter has been delayed. Energetic efforts are being undertaken in order to put it into service this year.

Even this long-awaited event, however, will not solve the cardinal problem. Due to a shortage of pig iron only 50 percent of the mill's capacity will be utilized. This, again, means using the expensive imported slabs.

There will be no imported slabs when the new Number 5 blast furnace begins operation. Naturally, it must be built as quickly as possible. The USSR Minchermet has decided that the plant must secure for itself a super-capacity blast furnace of 5580 m^3 capacity. It will undoubtedly possess great advan-

tages over its modest Cherepovets predecessors. A single one of these gigantic blast furnaces would be able to meet the oxygen-blown converter's total requirement for molten iron.

However, we will again recall that the situation is such that the blast furnace must be built at super-high speed. The practice of past years, however, is such that the 5000 m^3 capacity blast furnace at the Krivoy Rog plant was erected in 46 months. Apparently, the Cherepovets blast furnace will not be able to make its appearance any earlier than 48 months after the start of construction. The start of construction, however, has not yet been arranged. These are the figures one obtains: over this period of time the "2000" mill should receive 2 million tons of imported slabs annually, while losing about 28 million rubles of profit per year.

The economics of construction do not promise to be profitable, either. For example, the construction costs for one cubic meter of useful volume in the medium-capacity blast furnaces of the Number 4 Karaganda metallurgical combine and the Number 5 Novolipetsk metallurgical plant are equal to 16,000-18,000 rubles, while the same cubic meter at the Cherepovets giant blast furnace costs 41,000 rubles.

It appears that these losses can be avoided if the existing blast furnaces are rebuilt, increasing their capacity, and the Number 5 blast furnace is constructed with a lower volume--3200 m^3. This would reduce considerably the losses for the razing and relocation of the existing buildings and structures as well as reduce the operational expenditures associated with consolidating the furnaces. In addition, fewer resources would go into designing, since it is possible to use the designs of similar existing blast furnaces. Finally, the construction time is speeded up by two years.

Naturally, the supporters of this proposal (including specialists at the plant) do not disclaim the super-capacity blast furnaces. However, while it seems that they do have a place at the new metallurgical plants, the expediency of their construction at currently operational enterprises must certainly be based on a consideration of the local conditions. In Cherepovets, as it seems to us, the conditions rule against the giant blast furnace.
[139-9512]

9512
CSO: 1842

SHORTCOMINGS IN METAL INDUS .IES

Moscow EKONOMICHESKAYA GAZETA in Russian No 11, Mar 80 p 2

[Unsigned article: "To Improve the Quality and Utilization of Metal"]

[Text] At present the stock of metal in the USSR is reaching 1.4 billion tons, and every year it is replenished. This is a great resource of the people which must be augmented and preserved and must be rationally utilized in all sectors of production.

Our country has the largest metallurgical complex in the world. Its creation is the result of the unremitting concern of the Communist Party for the development of this branch of heavy industry. State capital investments in ferrous metallurgy have constituted around 40 billion rubles just in the last 15 years. Sixteen large blast furnaces, 29 oxygen converters, 40 hot and cold rolling mills, and 30 tube mills have been built, and significant capability has been brought into operation for iron ore output and for production of coke, agglomerates, and pellets. The smelting of steel and output of rolled metal during the period has grown by a factor of about 1.8. In the production of steel our country occupies first place in the world. In the present year, the smelting of steel is scheduled to increase to almost 157 million tons, rolled steel to 109 million tons, and steel pipe to 18.5 million tons.

Factors of Quality

At the present stage of scientific-technical progress, the factor of quality has become a determinant both in metallurgy and in all metal-using industries. The wide introduction of scientific achievements makes it possible to lower metal content significantly and to increase the reliability and durability of hardware in machine building and building structures, and to guarantee by such means a growth in the effectiveness of public production.

Since the beginning of the tenth five-year plan, a large amount of work has been done in ferrous metallurgy on the introduction of progressive engineering and technology. More than 500 new economical types of rolled

metal and steel pipe have been assimilated. Owing to the increase in the assortment and rise in quality in the economy, about a million tons of metal are being saved each year.

However, in view of the scale and complexity of the tasks put before the metallurgists by the party and government, the results achieved cannot be recognized as satisfactory. Metal, despite its great volume of production, limits the development of the economy to a certain extent.

The reasons for such a situation, as was noted in a speech at the November (1979) Plenum of the CPSU Central Committee by Comrade L. I. Brezhnev, are the slow realization of basic qualitative changes in metallurgy itself and a lag in introducing new technological processes into metal-consuming fields of industry. Negligence is tolerated in the storage and utilization of metal. All of this requires decisive measures for technical improvement of production and better itilization of existing systems.

In January and February of the current year, the average daily output of iron, steel, and rolled metal increased significantly in comparison with the same period last year. However, the plan for the two months nevertheless was not entirely fulfilled. There are still some enterprises that lag. Among them are the Nizhniy Tagil Combine and the Yenakievo, Kramatorsk, Dneprovskiy, and a number of other plants where the internal resources are poorly utilized.

It is urgently necessary to assimilate the experience of advanced enterprises. Thus, much attention is being given to the rise in quality at one of the largest enterprises in the country: the Novolipetsk Plant. The metal products made here are receiving practically no complaints. Good reputation is enjoyed by products of the "Elektrostal'" and "Dneprospetsstal'" Plants, which supply metal for the most crucial purposes to machine building, instrument building, and to the automobile, chemical and other branches of industry.

The collectives of the Ashinskiy and Omutninskiy plants and others are fruitfully occupied in improving the quality of metal.

The experience in the modernization of rolling mill equipment on a new technical basis, which results from the creative teamwork of specialists of the Cherepovets Metallurgical Plant and scientists of the All-Union Scientific Research and Planning Design Institute of Metallurgical Machine Building, deserves wide dissemination. Labor productivity of rolling mill personnel has grown 20 percent. The application of new technology has already permitted the saving of 250 thousand tons of metal.

However, in many collectives the struggle for high effectiveness in production and quality of metal is still weakly pursued; new equipment is not assimilated within the designated time periods; technology breaks down; and products are often turned out with deviation from standards

and technical specifications. This shows serious shortcomings at the enterprises and insufficient control of their activities on the part of the USSR Ministry of Ferrous Metallurgy.

Improvement in the organization of production, a rise in quality, and a broadening of the assortment of metal products depend largely on hastening the assimilation of new capabilities now being put into practice in the so-called fourth phase, where rolled metal undergoes supplementary treatment and acquires new qualities.

Recently, new capabilities for the chrome-plating of tin plate were put into practice at the Lys'venskiy Metallurgical Plant. This will permit an increase of 10 percent in the country's output of steel sheet metal with anticorrosive covering. It is now up to the metallurgists of the Lys'venskiy Plant to work the new production into plan indices as soon as possible.

No less an important task faces the builders and operational personnel of the carbon-steel cold-rolling shop of the Novolipetsk Metallurgical Plant. This industrial complex is now at the stage of getting ready for production.

Toward Full Capacity

But the assimilation of new capabilities for the output of quality metal is not always and not everywhere organized in the required manner. For the time being, a large new electric steel smelting shop at the Uzbek Metallurgical Plant is working at half-capacity. At the Novokuznetsk Combine in recent years the department for the heat treatment of railroad rails has been rebuilt and expanded. But full output from this undertaking has not yet been achieved. The new equipment has not been introduced into the planned regime of work.

Builders must make their contribution to the struggle for raising the quality of metal. This has to do with the concentration of effort of construction organizations on the decisive objectives of the fourth phase and on shortening of the time period for the introduction of a capability into operation. Meanwhile, the construction of a high-capacity shop for the production of thin tin plate at the Karaganda Metallurgical Combine is being dragged on and on. Lagging construction is continuing even in the current year. The organizations of the USSR Ministry of Construction of Heavy Industry Enterprises and the USSR Ministry of Installation and Special Construction Work together with the Karaganda metallurgists are called upon to increase the tempo of their work significantly.

The basic task of metallurgists is to guarantee fulfillment of the plan for realizing production in terms of realistic indicators and for the whole tasked assortment in accordance with agreements with consumers.

A large role in stimulating work on expanding the assortment and on raising the quality and effective utilization of metal products is being played by the measures for improving the administrative mechanism being implemented according to the decree of the CPSU Central Committee and the USSR Council of Ministers on 12 July 1979. Precisely this must be the subject of special concern of executive managers and party organizations of enterprises. Planning organizations have developed corresponding normative acts. The task of the ministries is to put them into practice in conformance with the conditions in each branch of the economy.

It Concerns Everyone

A conservative attitude toward metal and economical usage are no less a pressing task than are the growth of its production and improvement of quality. For example, the substitution of stamped and welded rolled steel stock and sheet metal for cast products is tied to the technical rearmament of state procurement production in the machine building branches of industry. Meanwhile, cutting remains the basic method of working metal. The progressive processes of stamping, pressing, and upset forging are insufficiently employed. Therefore, the coefficient of metal utilization in machine building remains at 0.72. As a result, up to 8 million tons of metal each year are forced into cutting.

The USSR State Committee for Material and Technical Supply, on its part, is called upon to improve the planning of the burden of orders from rolling mills at metallurgical plants. Too often their specializations are violated.

In a number of instances, a great deal of metal of increased strength is being put into structures according to outdated standards. Such a practice, without any exaggeration, can be called extravagant waste. At the same time, it is also a large potential for economy.

Significant losses are caused by mismanagement in storing and dispensing metal products, and sometimes they are indeed wasteful. This takes place, for example, at "Lidsel'mash" plant in Grodnenskaya Oblast, at the "Krasnyy Aksay" plant in Rostovskaya Oblast, and in the management of "Tatenergostroy." Often, still, rolled metal is not sorted out by type and factory markings, it lies in disorder, and it deteriorates in rain and snow. A location of significant quantities of it is allowed for purposes that are not foreseen by the plan. All of these facts are in conflict with the course being followed for economy and conservation. People's inspectors, the "Komsomol'skiy Prozhektor," and labor collectives are called upon to play an active role in eradicating such deficiencies.

Every labor collective must participate in the massive campaign for economy and conservation in the utilization of metal from production to consumption. Let us even take scrap metal collection. It cannot be looked upon as waste or refuse. It is a valuable secondary raw material. A third of

all steel in the country is smelted from scrap metal. The collection and processing of a ton of scrap metal requires a capital investment one twenty-fifth that of smelting a ton of "fresh" cast iron from natural raw materials.

Scrap metal comes from industrial and transportation enterprises, construction, city administration, kolkhozes, and sovkhozes. Taking stock of it and collecting it in many instances are poorly provided for. Improvement in this business depends not only on organizations of "Vtorchermet" [State Trust for the Procurement and Processing of Secondary Ferrous Metals], but also on the managers of every enterprise, on the careful sorting of the scrap and on timely removal by truck and rail transpor tation.

According to calculations made by scientists, about 10 to 15 million tons of metal each year are carried away, "eaten up," by corrosion. Metal needs to be protected. For this purpose, scientific-research organizations must participate more actively, creating modern methods and means for anticorrosive coverings.

Thus, the front of work for an economical, more rational utilization of metal--a valuable resource of the people--reaches all spheres of labor activity.

Socialist competition is spreading still more broadly for the worthy welcome to the 110th anniversary of V. I. Lenin's birthday and for the successful completion of the tenth five-year plan. The celebrated collective of the Magnitogorsk Combine exhibits forms of a Leninist model of work. Having fulfilled the tasks of four years of the five-year plan with honor, it has committed itself to exceed the 1980 plan in all basic indices, achieving all growth in production through raising labor productivity, assimilating 23 new types of rolled metal, and bringing the share of products with the State Mark of Quality up to 25 percent of the total volume of production. This commitment is being realized and the combine is working steadily and well.

The leaders of competition in all branches of the economy have accepted and are fulfilling their plans and obligations and are achieving economical utilization of material resources and of metal first of all. The wide dissemination of their experience is an important state matter.
[129-9645]

9645
CSO: 1842

MAGNETODYNAMIC PUMP FOR AUTOMATIC METAL POURING INTRODUCED

Moscow IZVESTIYA in Russian 15 May 1980 p 2

[Article by IZVESTIYA correspondent S. Tsikora: "Novelty in the Foundry"]

[Text] The profession of foundry hand has always been considered a difficult one. If one just takes such a labor-intensive operation as metal casting. In the foundries of even the most modern plants, both in our country and abroad, the liquid metal is most often cast manually or using a mechanical device repeating these same manual operations. A foundry hand should make many hundreds of ingots during a shift.

These are the working conditions. And now about quality. Metal casting from a ladle is the operation which influences casting quality the most. It is difficult to speak about the stability of the process, the accuracy with which the heating conditions are maintained, the high purity of the alloy when all of these parameters depend significantly on the skills, the attention and the qualifications of the foundry hand.

Science has come to their assistance. Scientists at the Institute of Casting Problems of the UkrSSR Academy of Sciences have created a device which is still unknown in world practice. They called it a magnetodynamic pump, abbreviated as MDP. And this machine was designated for automatic casting of liquid metal.

When the scientists showed their brainchild to production workers for the first time, the workers examined the unheard of machine with interest, but in their hearts they had doubts. Both the simplicity of operation and the universality of the device troubled them. The pump transfered the liquid metal through a pipe as if it were water. The casting form was filled with the metal with the same rapidity, accuracy and facility as a glass is filled with carbonated water from a dispensing machine. Moreover, the liquid metal was transfered under the influence of a magnetic field. The device created by the scientists permitted the use of ladleless methods for casting metals.

This meant a revolution in foundry matters. Manual labor was totally eliminated. The foundry hand could even put on white coveralls and control the electromagnetic field, which performed all necessary operations with the liquid metal, from a control panel.

But the laboratories of an academic institute are not plant foundries. Production workers create the reputation for a machine.

The magnetodynamic pump underwent the most arduous testing in the shops of the "Kievtraktorodetal'" production association. The working conditions here for foundry hands are the same as at other enterprises in the country. Therefore the cases of the association management may be considered typical: chronic lack of workers in the foundries and the endless search for technical innovations for mechanizing heavy and monotonous work. The news about the new item created at the Institute of Casting Problems of the UkrSSR Academy of Sciences was naturally greeted here with interest. But incorporating the pump immediately turned out to be impossible. It could transfer aluminum, zinc and type metal, but not pig iron. And the "Kievtraktorodetal'" foundries work precisely with pig iron, the material most widespread in machine building. The development of a pump design capable of operating with liquid pig iron would represent the solution of the "casting problem" for most of the machine building sectors.

The association management took a technical risk and made certain sacrifices. The risk was a decision to incorporate in their plants a device which had not existed previously. And the sacrifices were in the form of assistance to the Institute's Department of Magnetodynamics, where the new unit was born, with engineers from the plant. The work lasted several years. Today almost two dozen magnetodynamic pumps are in operation in the foundries of the "Kievtraktorodetal'" association, and the foundry hands have become the operators for the new devices.

The specialists of the Institute of Casting Problems of the UkrSSR Academy of Sciences and the association workers were recently awarded the UkrSSR State Prize for development and incorporation of this machine. Other awards merited by various modifications of the unit -- the First Degree Diploma at the "Interlitmash-72" international exhibition, the Gold Medal at the "Aluminum-75" exhibition, and the Gold Medal at the 1977 Leipsig Fair -- preceded this honor.

Properly, the scientific part in the biography of the MDP ends here and a second, no less complex stage, determining the quantity of the new product to be produced, the mass introduction of magnetodynamic pumps at enterprise foundries, begins. For a technical innovation is capable of solving social problems -- increasing productivity and labor quality and improving the working conditions of man -- only when it is widely used.

Until recently, the main source of magnetodynamic pumps was the experimental production of the Institute, and the experimental subdivisions were highly interested in obtaining the new product as quickly as possible for their own shops. Thus the MDP appeared in a number of plants in Moscow, Leningrad, Kiev, Konotop, Ufa and Ust'-Kamenogorsk. But this was only a drop in the sea of demand.

The recently adopted decree of the CPSU Central Committee and the USSR Council of Ministers "On the Significant Elevation of the Technical Level and the Ability of Metalworking, Casting and Woodworking Equipment and Machine Tools to Compete" dotted all the "i's" to the protracted problem of series production of magnetodynamic pumps. Now industrial production of magnetodynamic units for automatic pig iron pouring on a conveyor will be performed by the Pinsk Casting Equipment Plant of the USSR Ministry of Machine-Building and Tool Industry. This means that each newly produced automatic molding line will be equipped with a magnetodynamic installation, and those already in operation will be modernized.

But the technical potential of the idea itself of "controlling" a liquid metal using a magnetic field has far from exhausted itself. The MDP has permitted us to solve only one of the problems, casting pig iron in foundry production. Automation of steel teeming is next in line for investigators. And in the future lies ladleless transport of metals by creating continuously operating units in ferrous metallurgy.
[146-9194]

9194
CSO: 1842

UDC 666.3.32

SELECTION OF DRYING-GRANULATION UNITS FOR PRODUCTION OF SPECIAL CERAMIC MOLDING POWDERS

Moscow STEKLO I KERAMIKA in Russian No 4, 1980 pp 18-19

POLYAKOV, A. A., LYKOV, M. V., URTAYEV, A. A., Rybino Aviation Engineering Institute

[Abstract] The two existing methods of calculating drawing-granulation units are considered. The first method is based on the material and thermal balance of the process of spray drying when the volume of the drying chamber required for evaporation of a required amount of moisture at a selected specific mousture content is determined. The second method is based on the principle of calculating the height and diameter of the burner. Counterflow spray dryers for ferrite and thermoresistor materials are calculated. The dimensions of drying chambers required for the investigated materials should be greater than those calculated by the previous methods. The investigations made it possible to select and conduct industrial trials of a drying-granulation unit for production of ferrite and semiconducting thermoresister molding powders and also to calculate the dimensions of drying chambers for ceramics based on aluminum oxide, used in manufacture of dielectric articles. Figures 2.
[147-6521]

UDC 661.66.3

ON THE STRENGTH OF GRAPHITES BASED ON CALCINATED AND UNCALCINATED COKE

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 23-26 manuscript received 26 Jul 78

GUSMAN, N. O., CHERNYKH, V. A., CHERNYAVETS, A. N. and BAGROV, G. N., Moscow

[Abstract] Synthetic graphite made from coke forming at approximately 560° C has a much higher mechanical strength than graphite made from coke calcinated at 1200-1300° C. The causes of this difference are analyzed by the method of linear fracture mechanics. Accordingly, data on the dynamic modulus of elasticity and readings of tensile tests are evaluated in terms of toughness. On this basis, with numerical values appropriate for both variations of coke, the tensile strength squared is found to be approximately proportional to the effective toughness and, moreover, graphite from uncalcinated coke is much tougher. This is explained by a higher binder-graphite content and correlated with the grain-size distribution, the strength of a fine fraction increasing with toughness much faster than does the strength of a coarse fraction. Figures 1; references 10: 7 Russian, 3 Western.
[139-2415]

UDC 620.178.16:669.295

GAS-ABRASIVE WEAR RESISTANCE OF AT3 AND AT6 TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 34-36

BORISKINA, N. G., BRYSKIN, A. M., and KENINA, YE. M.

[Abstract] Titanium alloys are used for pipes in deep oil wells where aluminum alloys do not withstand the high-temperature corrosive environment. However, despite their superior mechanical properties in most areas, titanium alloys have inferior wear resistance. Since the corrosive action of the environment has some effect on wear resistance, the authors studied the influence of temperature, mineralization, pH, and rate of corrosion flow on gas-abrasive wear of AT3 and AT6 industrial titanium alloys. The study was based on the method of mathematical planning of experiments. It was found that the determining factors in gas-abrasive wear of these alloys are temperature and the pH of the corrosive solution. Neither mineralization nor the rate of the corrosion flow had any effect on gas-abrasive wear of either alloy. Wear was insignificant in alkaline and neutral media at room temperature. After treatment in acid solutions ($pH < 4$) at high temperatures (250° C) both alloys showed intensive wear. AT3 alloy had higher corrosion and wear resistance that AT6. Both alloys are recommended for making deep-drilling pipes. Figures 2; references 7: all Russian.
[67-6610]

UDC 669.018.27'8'44

PRECIPITATION HARDENING OF Ni-(Co)-Cr-Nb ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 10-12

BARSEG'YAN, L. V., SAMARINA, N. M.,and SIDOROVA, I. B., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] To find a basis for developing precipitation-hardened spring alloys with high thermal stability, an investigation was made of the effect of cobalt on precipitation hardening and on the physical-chemical properties of Ni-(Co)-15Cr-10Nb alloys with cobalt content varying from 6.8 to 33.5%. Sheets 0.3 mm thick were made by hot and cold plastic deformation. The kinetics of precipitation hardening was studied from the change in hardness and in the mechanical and elastic properties of the specimens during aging after quenching to the solid solution from 1150° C in water. All alloys showed a pronounced precipitation hardening

effect and high strength and elastic properties with satisfactory relaxation stability at 500° C. Cobalt in amounts of 12.6-21.5% enhanced the precipitation hardening effect and raised the strength and elastic properties. The maximum effect was observed with a cobalt content of 21.5%. The main hardening phase was Ni_3Nb with a bct lattice. Figures 4; references 11: 6 Russian, 5 Western.
[67-6610]

UDC 620.18:620.17:669.725'26

STRUCTURE AND MECHANICAL PROPERTIES OF THE BERYLLIUM-CHROMIUM SYSTEM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 13-15

MOLCHANOVA, L. V., NAGORSKAYA, N. D., YATSENKO, K. P., MEZHENNYY, V. M. and KOLESNIKOVA, V. I.

[Abstract] Alloys of the Be-Cr system were studied by microstructural, thermal, x-ray, local x-ray spectral and chemical analysis and by measurement of microhardness. Beryllium content varied from 22.5 to 92.8% and chromium content, from 4.3 to 78.0%. It was found that phases crystallize that are based on beryllium and compounds of $CrBe_{12}$ and $CrBe_2$. The composition of $CrBe_{12}$ is apparently very close to the peritectic point on the phase diagram. Eutectic crystalli ation occurred with a content of 13.8% Cr at a temperature of $1240 \pm 10^{\circ}$ C. Binary alloys of beryllium containing up to 13% Cr had comparatively low strength -- no greater than 10-11.6 kgf/mm^2. When the beryllium-chromium alloy was doped with nickel or vanadium, the strength increased to 14-17 kgf/mm^2. The investigated alloys had low ductility. Figures 4; references 10: 6 Russian, 4 Western. [67-6610]

UDC 621.762

PRODUCTION AND PROPERTIES OF DIAMOND-METAL SHEET MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 90-92
manuscript received 23 Oct 78

SOROKIN, V. K., TIKHONOV, G. F. and SHMELEV, L. S., Gorkiy Polytechnic Institute

[Abstract] Small diamond tools are now produced from metal and diamond powder mixtures. The technology involves mixing of powders for 6 hours, rolling of ingots with a porosity of 25-30%, sintering in a hydrogen atmosphere at 700-750° C for 2 hours, compacting, cold rolling with intermediate recrystallization annealing, and thermomechanical treatment. A study of this technology was made using Cu+ 6.5 wt.% Sn+ 4-13 wt.% Ni alloys and 26 vol.% synthetic diamond powder with the grain size varied from 3 to 28 μm. Mechanical tests revealed a successive increase in the ultimate strength of the product after quenching, cold working, and aging. The ultimate strength also increased with a higher nickel content and with a smaller grain size of the original diamond powder. The addition of 1% solid lubricant such as graphite or molybdenum sulfide had no significant effect on the strength of these materials. Figures 2; references 4: all Russian.
[75-2415]

UDC 620.18:699.017

STRUCTURIZATION IN (Ti, W)C-Co ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 78-84
manuscript received 14 May 75

TRET'YAKOV, V. I., CHERNYAVSKIY, K. S. and SENCHIKHIN, V. K., All-Union Scientific Research and Planning Institute of Refractory Metals and Hard Alloys

[Abstract] Structurization of (Ti,W)C-Co alloys with attendant quantitative changes during isothermal sintering was studied at 1500° C for 1-20 hours. Specimens of two alloys, one with 8 vol.% Co and one with 30 vol.% Co, were bilaterally molded into cylinders with a residual porosity of 45% and plasticized with a benzene solution of synthetic rubber. From chord measurements made on photographs of microsections, taken under a Neophot-2 reflection microscope, calculations were made of the volume fraction of the cobalt phase, the mean diameter of the carbide particles, the specific interphase surface area, the specific contact area, the relative contact area, the specific contact perimeter, and the mean free distance for cobalt. A statistical evaluation of the results indicates

a growth of carbide particles, a continuous decrease of the interphase surface and the specific contact area, and little change of the relative contact area over the 10 hours of isothermal sintering. The specific contact perimeter decreases continuously in the 30% Co alloy, but decreases during the first 5 hours and then increases during the last 5 hours in the 8% Co alloy. This latter trend is attributable to collisions between particles and their coalescence during later stages of the process.
Figures 4; references 10: 3 Russian, 7 Western.
[75-2415]

UDC 621.762

THE MOST SIGNIFICANT ACHIEVEMENTS IN THE AREA OF THE HOT PRESSING OF METAL POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 16-23
manuscript received 30 Apr 78

DOROFEYEV, YU. G. and KOVAL'CHENKO, M. S., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Powder metallurgy in the USSR has made great progress in both theoretical research and practical application since the first experiments with platinum reported by P. G. Sobolevskiy. A fundamental achievement was extending the power-law relation for viscous flow to non-Newtonian flow of porous solids such as carbon steel, and developing, on this basis, the technology of hot pressing. Much work was and is done at the Scientific Research Institute of Powder Metallurgy (Belorussian Polytechnic Institute), at the Institute of Problems of Material Science (Academy of Sciences UkrSSR), and at the Ukrainian Scientific Research Institute of Special Steels. Quasi-steady, dynamic and pulse hot pressing processes are being developed along with attendant heat treatment, preliminary cold pressing, sintering, graphitizing, and finishing rolling, stamping, and extrusion. Emphasis is placed on high product quality in terms of mechanical characteristics as well as on economical production.
References 36: 33 Russian, 3 Western.
[75-2415]

UDC 621.762

DILATOMETRIC STUDY REGARDING SATURATION OF THE MATRIX OF TITANIUM-GLASS MATERIALS WITH SILICON

Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 79 pp 10-15
manuscript received 9 Feb 79

VLASYUK, R. Z. and RADOMYSEL'SKIY, I. D., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] The hardness of titanium-glass materials is increased by saturation of the matrix with silicon during sintering. A study of this effect was made using various grades of window and Pyrex glass as filler, with an SiO_2 content from 60 to 99.9% and a softening or liquefaction temperature from 350 to 1500° C. The narrow temperature range of their interaction with the titanium matrix was determined from measurements involving differential dilatometry. Glass crystallization inhibited shrinkage at 600° C and, unlike the situation with iron-glass materials, saturation of the matrix with a corresponding decrease of the silicide phase was found to begin at 800-850° C. Figures 4; references 3: all Russian.
[75-2415]

UDC 533.9.07

EXPERIMENTAL DETERMINATION OF THERMAL AND GAS-DYNAMIC CHARACTERISTICS OF A PLASMA JET

Kiev POROSHKOVA METALLURGIYA in Russian No 11, Nov 79 pp 29-32
manuscript received 4 Dec 78

KARPINOS, D. M., MOROZOV, YU. I. and YAKOVLEV, K. I., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] An experimental study of cold plasma jets was made, as a basis for optimization of the plasma-spray deposition process in powder metallurgy. Radial and axial profiles of the thermal flux as well as total and static pressure in the jet were measured with a calorimetric probe including a Chromel-Copel differential thermocouple, a recording potentiometer, and a Pitot tube respectively. The jet was generated by an argon plasmatron with a copper anode-nozzle, eddy-current arc stabilization and water cooling. Calculations were made of the temperature of heavy particles, atoms, and ions, as well as the stream velocity and the stagnation enthalpy. The $q/^4$ P parameter, a function of the Prandtl number in dimensional analysis, and the equation of compressible adiabatic flow through nozzles were also used in the evaluation. Figures 2; references 7: all Russian.
[75-2415]

UDC 539.4.015

CONCERNING THE MECHANICAL STRUCTURAL STRENGTH OF SUPERHARD SYNTHETIC MATERIALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 90-95 manuscript received 3 Oct 78

MALIKOV, Zh. G. and SEMERCHAN, A. A., Moscow

[Abstract] The first attempt is made to apply the physicochemical theory of the strength of disperse porous structures to structures of superhard synthetic materials to do an approximate quantitative analysis of the mechanical strength of ballas, carbonado, cubic boron nitride and almet. An experimentally established equation for porous solids, which says that mechanical strength is equal to the product of the number of contacts per unit area of rupture surface and the force that bonds the particles at the contacts, is used for calculating the mechanical strength of the superhard materials. The role of microstresses in improvement of mechanical properties of superhard materi ls is examined and an equation is derived for calculating the mechanical structural strength of polycrystalline diamonds of the ballas and carbonado types, of the cubic boron nitride el'bor-R and almet, made from the powders of natural and synthetic diamond impregnated with metallic binder at high temperature and pressure. The mechanical strength of the materials may be viewed approximately as the result of the additive action of the binding forces of particles in the contacts. References 12: all Russian.
[124-7872]

UDC 620.186:621.789:669.295.5

CHANGE IN THE STRUCTURE OF HIGH-STRENGTH TITANIUM ALLOYS AFTER HIGH-TEMPERATURE THERMOMECHANICAL TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 23-25

POL'KIN, I. S., NOTKIN, A. B. and SEMENOVA, N. M., All-Union Institute of Light Alloys

[Abstract] A study was made of the effect of the structure of the β-solid solution formed in thermomechanical treatment, and the nature of segregation of the α-phase during subsequent aging on the mechanical properties of heavily doped titanium alloys. Analysis of the main patterns of dissociation of the β-phase shows that the mechanical properties of heavily doped titanium alloys after aging depend on the initial structure. The substructure has the greatest influence after aging at 450-600°C. Aging of the recrystallized β-phase leads to nonuniform segregation of α-phase of complex structure. The authors determine the optimum structure that yields a combination of high strength and ductility characteristics, and consists of plastic and hardened microtwins of -phases that are segregated along the boundaries of subgrains and within the subgrains respectively. Figures 3, references 5: 4 Russian, 1 Western.
[67-6610]

USING TAPERED ION BEAMS IN THIN-FILM TECHNOLOGY

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1(91), 1980
pp 68-70

DOSTANKO, A. P. and SHIRIPOV, V. YA., Minsk

[Abstract] The optimum design of a sputtering device based on accelerators with closed drift is an arrangement in which the ion beam source is situated between the backing and the target. In this case, the most suitable shape of the ion beam is conical, maximizing productivity by bombardment of the target surface at an angle, and reducing the distance between the target and backing. A facility is described that gives ion beams with current of up to 0.5 A at accelerating voltages in a range of 0.5-7 kV. Working gases are argon for sputtering the target, and argon, oxygen and nitrogen for treating the backing surface. It is experimentally shown that from 75 to 93% of the flux of sputtered material propagates in the direction of the backing in a solid angle of up to 100°, depending on the structural state of the target surface. Thus the diameter of the drift zone should be increased to maximize the efficiency of film application. It is also desirable to use a target with minimum grain size or grain orientation of the surface. Experiments were also done on using a tapered ion beam of argon for etching sputtered films through photoresistive masks. The results are promising. Figures 2; references 9: 4 Russian, 5 Western.
[127-6610]

UDC 669.295.5:539.217.5:669.788

HYDROGEN ABSORPTION BY TITANIUM ALLOYS DURING ANNEALING IN AIR

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 16-19 manuscript received 13 Sep 78

VIGDORCHIK, S. A., KOLACHEV, B. A. and FISHGOYT, A. V., Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy

[Abstract] When titanium alloys are annealed in air, their interaction with oxygen and water vapor results in formation of an oxide surface layer and in diffusion of hydrogen into the metal. An analysis based on a kinetic model assuming random motion of O_2 and H_2O molecules in the ambient medium in the furnace reveals and experimental data confirm that: 1) at a constant annealing temperature and absolute air humidity the mass of absorbed hydregen is proportional to the mass of absorbed oxygen; 2) at a constant annealing temperature and holding time the mass of absorbed hydrogen is proportional to the absolute air humidity; and 3) at a constant absolute air humidity and holding time the mass of absorbed hydrogen depends exponentially on the annealing temperature. Accordingly, a simple relation is proposed for the hydrogen flux into the metal, where the numerical coefficient has been found to vary from 0.6 for the OT4 alloy to 1.8 for the VT30 alloy and can be assumed to be equal to 1.3 for all titanium alloys. The hydrogenation process is further treated as a boundary-value problem for the hydrogen concentration and its distribution over the metal thickness. The relations are different for thin and thick metal layers, respectively. The solution to the problem in the thin-layer case confirms the absence of hydrogenation at temperatures below 800° C and virtually unmeasurable hydrogenation at that temperature. Figures 3; references 4: 3 Russian, 1 Western.
[132-2415]

UDC 539.43:669.715:620.191.33

CYCLIC CRACKING RESISTANCE OF VT20 TITANIUM ALLOY SHEET AND ITS ANISOTROPY

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 47-52 manuscript received 23 Nov 78

YAREMA, S. YA., GRECHKO, V. V. and OSTASH, O. P., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] Rolled sheet of VT20 titanium alloy (5.5-7.5% Al, 1.5-2.5% Zr, 0.5-2.0% V, 0.8-1.8% Mo) an α-phase alloy with a c.p.h. crystal structure containing 2-4% β-phase with a b.c.c. crystal structure, was tested for cracking resistance in the directions parallel and perpendicular

to the direction of rolling. Specimens 2 mm thick were loaded harmonically and almost symmetrically in tension at a frequency of 17-20 Hz. From the results of these tests and an evaluation of the measurements by the method of least squares, the distribution of stress concentrations as a function of the crack length was calculated and the fatigue diagram in universal coordinates plotted for specimens with longitudinal cracks and for specimens with transverse cracks, in their general behavior not different than specimens of other material. A strong "reverse" anisotropy was manifested in the higher static and dynamic cracking resistance (more ductile fracture under static loads and greater toughness under impact loads) of specimens with longitudinal cracks. Figures 3; references 13: 10 Russian, 3 Western.
[132-2415]

INVESTIGATION OF FILM FORMATION AND SURFACE ROUGHNESS IN ELECTROCHEMICAL MACHINING OF TITANIUM ALLOYS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1(91), 1980 pp 26-29

KUKOZ, F. I., KUDIMOV, YU. N. and SHAKHBAZYAN, V. V., Novocherkassk

[Abstract] An investigation is made of film formation and surface roughness when holes are pierced in titanium by electrochemical machining on a laboratory facility with fixed electrodes at low current densities. The process was started at high electrode voltage (20 V), and then the voltage was reduced at a rate of 3 V/sec with stabilization when a current density of 4-5 A/cm^2 was reached. The initial interelectrode gap was 0.3 mm, and the flowrate in the gap was 3.5-4.5 m/sec. The electrolyte was a solution containing 20% $NaNo_3$ + 5% KCl + 2% $NaNO_2$ + 5% KBr. Specimens were VT4, VT6 and VT1-0 titanium alloys. It was found that the film formed on the surface of the specimens is titanic acid. Multifactor experiments were done to determine the simultaneous influence of current density, flowrate of the electrolyte, time of treatment and concentration of alloying components on surface roughness and film formation. The results show that surface roughness can be reduced by increasing current density and electrolyte flowrate. Surface roughness is also reduced by increasing the concentration of alloying elements. Current density must be high to reduce film formation even when flowrate is increased. Figures 2; references 15: all Russian.
[127-6610]

STRUCTURAL FEATURES OF SURFACE LAYERS AFTER ELECTROSPARK DOPING OF VT-18 TITANIUM ALLOY WITH ALUMINUM UNDER STRINGENT CONDITIONS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1(91), 1980 pp 30-32

PILYANKEVICH, A. N., PADERNO, V. N., VERKHOTUROV, A. D., MARTYNENKO, A. N. and SMIRNOV, V. P., Kiev

[Abstract] Electron microscope studies were done on the formation of a tough layer when electrospark treatment was used for doping VT-18 titanium alloy with aluminum at a pulse energy of 3 J, short circuit current of 4.6 A and open-circuit voltage of 130 V for treatment times of 5 sec/cm^2 (one pass), 10 sec/cm^2 (two passes), 15 sec/cm^2 (three passes), 2, 5, 8, 10, 12 and 14 min/cm^2. It was found that after the third pass of the tool, the microhardness of the tough layer had increased considerably, but brittle fracture had occurred in microvolumes of the surface, and after a specific treatment time of 5 min/cm^2 there was a noticeable weight loss due to chipping of the embrittled material under the action of high thermomechanical stresses. Therefore it is recommended that the specific doping time be shorter than 2 minutes per cm^2 for electric spark toughening of these materials under the given conditions. Figures 5; references 6: 5 Russian, 1 Western.
[127-6610]

UDC 669.295.788:621.791

HYDROGEN ABSORPTION BY TITANIUM ALLOYS

L'vov FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 2, Mar-Apr 80 pp 19-23 manuscript received 2 May 77

NAZIMOV, O. P. and IL'IN, A. A., Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy

[Abstract] An experimental study was made to determine the effect of vanadium, molybdenum and chromium in titanium alloys on the hydrogen absorption by titanium, in wrought specimens pre-annealed in vacuum at 1100° C for 2 hrs. After hydrogenation, the same specimens were annealed again in vacuum but at 1000° C for 5 hrs. Experimental data on the dependence of hydrogen solubitity on the concentration of alloying elements and experimental data on the hydrogen distribution in welded specimens were interpreted in terms of the phase structure. An increase in the V,Mo,Cr content was found to lower the hydrogen solubility in β-phase alloys and to raise it in α-phase alloys. Aluminum had the opposite effect in α-phase alloys; no data were available on its effect in β-phase alloys. It can be concluded that an alloying element lowers

the hydrogen solubility in the titanium modification which it stabilizes. A correlation has been established between the heat of dissolution for these three alloying elements and the interatomic bond strength, the latter corresponding to a characteristic temperature. The better an alloying element strengthens the interatomic bond, the more it lowers the hydrogen solubility. This effect varies with the concentration of the alloying element, at a different rate for each. Figures 3; references 5: 4 Russian, 1 Western.
[132-3415]

UDC 669.295:621.7

ON THE OXIDATION OF TITANIUM SPONGE DURING CRUSHING

Moscow TSVETNYYE METALLY in Russian No 4, Apr 80 pp 61-64

TITARENKO, A. I., PAVLYUCHENKO, A. N., SANDLER, R. A., and VOLEYNIK, S. N.

[Abstract] A study was made of changes in the quality of titanium sponge, essentially due to oxidation, during high-speed crushing processes with attendant effects of friction and plastic deformation. The residue of specimens and the chips or lumps were classified on the basis of color into: 1) silvery, unoxidized, 2) light yellow, slightly oxidized, and 3) red and violet or blue, heavily oxidized. A comparison was also made with specimens of compact titanium similarly treated. Further metallographic analysis, under the microscope and by x-radiography, revealed that oxidation of titanium sponge can be avoided in any crushing process (grinding with an abrasive wheel, grinding with a ratchet wheel, crushing with rollers) except in crushing with jaw plates. The crushing processes can be further optimized by appropriately matching the speed with the degree of porosity and by providing adequate removal of heat. Figures 3; references 6: all Russian.
[137-2415]

UDC 539.32:669.018.47:669.295

ELASTIC MODULI, COEFFICIENTS OF THERMAL EXPANSION, AND DEBYE TEMPERATURE OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, 1979 pp 36-38

BELETSKIY, V. M., GLEY, V. A., MAKSIMYUK, P. A., TABACHNIK, V. I. and OPANESENKO, V. S.

[Abstract] An investigation was made of the characteristics of titanium alloys that are determined by the forces of interatomic bonds: moduli of elasticity and their temperature dependences, coefficient of thermal expansion, and Debye temperature. The studies were done on pure titanium, and on VT1-0, VT16 and VT22 alloys. The ultrasonic echo-pulse method was used to study the elastic moduli and their variation with temperature. It was found that the Young modulus and its temperature variation depend on the content of doping elements in the alloy. The reduction in the Young modulus with temperature can be explained within the framework of the theory of anharmonic effects. Doping also determines the increase in forces of interatomic interaction. Strength increases with increasing interatomic interaction that shows up in a change of Debye temperature, coefficient of thermal expansion, and elastic moduli. Analysis of the results shows that aluminum doping of titanium alloys increases interatomic interaction, which may be responsible in part for increased strength of the alloys. Figures 3; references 3: all Russian.
[67-6610]

UDC 669.295'28'293'27:620.17:620.18

INFLUENCE OF MOLYBDENUM, NIOBIUM, AND TUNGSTEN ON THE MECHANICAL PROPERTIES AND STRUCTURE OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 12, 1979 pp 32-34

ULYAKOVA, N. M.

[Abstract] An investigation was made of the influence of molybdenum, niobium, and tungsten in amounts of 0.5, 1.5, 2.5, 3.5, and 4.5% on the mechanical properties of an alloy of Ti-6.5Al-4Zr-2Sn at 20° C in the initial state and after additional heating at 600° C for 100 hours. The mechanical properties of the alloys were studied at 500-650° C, permanent strength at 500 and 600° C, and creep at 600° C. It was found that molybdenum increases the permanent strength of the alloy at 500° C at

all concentrations from 0.5 to 4.5%, and that doping with 1.5% molybdenum increases permanent strength at 600° C. Tungsten has the maximum effect on improving creep resistance at 600° C. Niobium is detrimental to the high-temperature properties of the alloy. Figures 4; references 4: 1 Russian, 3 Western.
[67-6610]

UDC 669.295.5+669.85/86+669.296+669.297

MICRODOPING OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 29-31

KHOREV, A. I.

[Abstract] An investigation was made of the way that titanium alloys with $\alpha+\beta$- and β-structure are influenced by trace doping with elements of groups III (Y, Gd, Dy), IV (Zr, Hf), and VII (Re) of the periodic table. It was found that these dopants reduce grain size and the impurity content along grain boundaries, and also promote more highly dispersed and uniform dissociation of metastable phases during aging, thus enhancing the mechanical properties of the alloys in conformity with the increasing negative values of the heat of formation of the oxides of these elements. The ductility of welds of the alloys is increased by a factor of 3-5. The degree of improvement of mechanical properties depends on the structural state, and increases from the annealed to the tempered state, and from equiaxial to coarse superheated and cast structure. The most effective microdoping concentration for zirconium and hafnium is 0.02-0.1% for $\alpha+\beta$-alloys, and 0.5-1.5% for β-alloys. The optimum concentration for the rare earth metals as trace dopants is 0.02-0.05% for both $\alpha+\beta$- and β-alloys. Figures 3; references 6: all Russian.
[67-6610]

UDC 669.295.017:539.4

SUPERPLASTIC DEFORMATION -- A METHOD OF IMPROVING THE MECHANICAL PROPERTIES OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 12, 1979 pp 26-28

KAYBYSHEV, O. A. and SALISHCHEV, G. A., Ufa Aviation Institute imeni Ordzhonikidze

[Abstract] A study was made of the effect of types of treatment, including treatment with the use of the effect of superplasticity, on the structure and properties of VT9 titanium alloy (6.7% Al, 3% Mo, 1.7% Zr, 0.17% Fe, 0.27% Si, 0.09% O, 0.01% C, 0.02% n, 0.002% H). The mechanical properties of the alloy were studied after deformation with superplastic flow, and after thermomechanical treatment, and were found to be comparable. Tensile strength, fatigue limit, and impact toughness were higher than for conventional heat treatment, and ductility was not impaired. Deviation from optimum conditions of superplasticity increased strength, but was detrimental to ductility and thermal stability. Superplastic deformation improved the structural and chemical homogeneity of the alloy. Figures 1; references 10: 9 Russian, 1 Western.
[67-6610]

UDC 621.791.621.014.25

WAYS TO INCREASE THE STRENGTH OF WELDED JOINTS BETWEEN PARTS MADE OF 2-PHASE TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 3, Mar 80 pp 49-52 manuscript received 18 Jul 78; after final revision, 27 Nov 78

ZAMKOV, V. N., Candidate of Technical Sciences, KUSHNIRENKO, N. A., Candidate of Technical Sciences, TOPOL'SKIY, V. F., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR; POL'KIN, I. S., Candidate of Technical Sciences, All-Union Institute of Light Alloys; KHOREV, A. I., Candidate of Technical Sciences, All-Union Scientific Research Institute of Aircraft Materials

[Abstract] Heat-hardenable titanium alloys essentially of the ($\alpha+\beta$) 2-phase type and including medium-alloy martensitic ones (VT14, VT6, VT6S) and high-alloy grades (VT22, VT23), are used widely in many critical welded structures. The strength of such joints cannot be increased by heat treatment applicable to the base metal. Instead, a buildup of the seam of a more expedient "soft" heat treatment is required. Results of a planned experiment indicate that the optimum aging temperature for such joints lies within the 350-390° C range. The quenching temperature should be 20-30° C below the polymorphous transformation temperature so that the plasticity of the joint will be increased. The experiment was followed by a study of a welded section including the seam and a 5-mm-thick layer of VT14 base metal. The phase composition was examined by selective anodic isolation with subsequent x-ray structural and chemical analyses. According to the results, aging at 620° C for 2.5 hours yields the best joint between parts made of hot-rolled VT14 containing more than 5% aluminum. The characteristics of a joint can be improved further by adjusting the chemical composition of the seam metal with the use of appropriate welding rods. The addition of one eutectoid-forming β-phase stabilizer must be avoided, because it would lower the plasticity, but the addition of several isomorphous β-phase stabilizers is recommended. Molybdenum and vanadium are effective hardeners, niobium improves the ductility and zirconium reduces the detrimental effects of oxygen. With rhenium also added as a desirable modifier, a Ti-Al-Mo-V-Nb-Zr-Rh welding rod has finally been developed which is suitable for all those 2-phase titanium alloys. Ye. N. TSEYGER (Northwestern Polytechnic Correspondence Institute, Leningrad) isolated the phases and analyzed their chemical composition. References 5: all Russian.
[142-2415]

UDC 621.791.052.08:669.295

WELDING OF THE AT6 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 4, Apr 80 pp 56-60 manuscript received 1 Mar 79; after final revision, 10 Apr 79

BLASHCHUK, V. YE., engineer, DZYKOVICH, I. YA., Candidate of Technical Sciences, ONOPRIYENKO, L. M., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR; SHELENKOV, G. M., Candidate of Technical Sciences, Sumy Machinery Manufacturing Association imeni M. V. Frunze

[Abstract] The AT6 corrosion-resistant high-strength titanium alloy (5.5% Al, 0.5% Cr, 0.5% Fe, 0.35% Si) is used, especially in the food industry, for equipment operating at temperatures up to 500° C. An experimental study was made to determine the behavior of joints produced by argon-arc manual welding or automatic welding with electromagnetic stirring. Specimens for this study were cut from hot-rolled 20-mm-thick strip, annealed at 700° C, and welded with a tungsten electrode, manually (PRS-3EMP welder) or automatically ("Neptun" EMP welder) and respectively with or without a filler alloy. A metallographic analysis of the welding seams and mechanical tests of the joints indicated that automatic welding should produce joints 90% as strong as the base metal, and argon-arc manual welding should produce 90% strong joints with the AT3sv alloy as filler or 80% strong joints with the 2V alloys as filler. Electromagnetic stirring enhances the corrosion resistance of these welded joints in citric acid and in tartaric acid. Figures 5; references 6: all Russian. [135-2415]

UDC 621.791.72.011

WELDABILITY OF AK4 HIGH-TEMPERATURE ALUMINUM ALLOY BY ELECTRON BEAM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 32-33, 45 manuscript received 31 Jan 79, after revision 19 Mar 79

BONDAREV, A. A., Candidate of Technical Sciences, and CHERNOV, V. YU., engineer, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] Grade AK4 alloy of the aluminum-copper-magnesium-iron-nickel-silicon system differs from other aluminum alloys in that it contains no manganese, chromium, zirconium or other elements that produce the press effect. As a result, the alloy is isotropic. The total content of principal dopants (copper and magnesium) in AK4 alloy is 4-5%. The retention of mechanical properties at high temperatures is enhanced by considerable

amounts of weakly soluble or nearly insoluble components -- iron, nickel and silicon. Although the alloy is widely used, it cannot be satisfactorily welded by arc methods. The authors investigated the feasibility of using this alloy in structures made by electron-beam welding. Before the welds were made, the plates were etched in 15% caustic soda at 50° C and brightened in a 30% solution of nitric acid. The welds were tested at 20-360° C on circular specimens with a working section 6 mm in diameter cut across the weld. The specimens were held at the test temperature for 20 minutes. The tensile strength of the welds was found to be higher than that of the plate metal. The impact strength of the welds was on the level of that of the plate metal or somewhat higher at room temperature, but noticeably lower than the impact strength of the plate metal at elevated temperatures. The fatigue strength of aged or quenched and artificially aged welds was found to be close to that of the plate metal. The hardness of the weld metal after heat treatment was somewhat higher than that of the plate metal. Aging alone is not sufficient for restoring the properties of the weld to those of the plate metal. The welds must be quenched and artificially aged. Figures 4; references 4: all Russian.
[94-6610]

UDC 621.791.754'264

INVESTIGATING THE PRESSURE OF THE VAPORS AND GASES WHICH FORM A PROTECTIVE MEDIUM DURING WELDING IN A CARBON DIOXIDE RING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 3, 1980 pp 9-11

VINOGRADOV, V. S., KUZNETSOV, M. V., Moscow Aviation Technological Institute imeni K. E. Tsiolkovskiy

[Abstract] Electric strain measurement of the pressure of the vapors and gases which form a protective environment in welding with a circular carbon dioxide flux were studied. A special tensometric pressure converter which uses a flat thin membrane with PBK-10-100 strain guage resisters glued to the center, with two each on each side, was developed. The metal membranes manufactured from plates of minimum thickness were tested and were found to be too rigid, and the sensitivity was found to be insufficient to record low pressures. PETF-A metal-coated polyethyleneterephthalate film was selected as the material for the sensing element of the converter. The film has high strength characteristics and lower weight than polytetrafluoroethylene, and the metal-coated surface of the file also has good adhesion when gluing the strain guage resisters. The membrane which was made rigid around the contour of the body was timed by a clamping ring using a threaded ring to eliminate buckling and development of depressions which lead to instability of the converter characteristics. The measurements showed that the vapor and gas pressure inside

the CO2 ring flux increases as the consumption of the shielding gas increases. The excess pressure is not observed when welding with a burner having an enclosing carbon dioxide shield. Figures 5; references 11: all Russian.
[148-6521]

UDC 621.791.01:669.017.3

KINETICS OF TRANSFORMATIONS DURING THE WELDING OF HEAT-HARDENED GRADE 1201 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 29-31, 39
manuscript received 16 Jun 78

ISHCHENKO, A. YA. and LOZOVSKAYA, A. V., Candidates of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] Grade 1201 alloy of the aluminum-copper-manganese system is hardened by quenching and artificial aging. Natural aging leaves the strength of the alloy practically unaltered. Maximum hardening is realized when the quenched solid solution is aged at 160-180° C. In various stages of the hardening process, Guinier-Preston zones G.P. 1 and G.P. 2 are formed, and the θ'-phase, which is a metastable form of the θ-phase ($CuAl_2$), is precipitated. However, this state of the alloy is unstable. Welding temperatures produce unfavorable changes in the properties of the material both in the seam and in the heat-affected zone. A repeat artificial aging of metal softened by welding partly restores hardness throughout the heat-affected zone, and drops in the hardness curve are shifted toward lower temperatures. The individual stages of the structural transformation that leads to a change in hardness are difficult to observe directly because the section of the investigated zone is small, and the processes take place without demarcation. In this paper the authors study these transformations on specimens of hardened grade 1201 alloy heated under conditions simulating the thermal welding cycle at certain characteristic points of the heat-affected zone. The change in microstructure and hardness of the metal was analyzed as a function of the time-temperature schedule of the experiments. Kinetic diagrams of softening of the alloy are plotted from the results of experiments with heating in a metal bath and cooling at various rates. These diagrams can be used to determine the hardness of the alloy in the heat-affected zone for various welding methods and conditions. Analysis of the influence of temperature on the physical and mechanical properties of grade 1201 alloy in the heat-affected zone must take account of the structural transformations of the age-hardened solid solution of copper and aluminum. Brief heating to temperatures in excess of 350° C partially

returns the alloy to the quenched state, but temperatures below 300° C leave the microstructure and hardness of the alloy nearly unchanged. Figures 5; references 5: all Russian.
[94-6610]

UDC 621.791.01

THERMAL DIFFUSION OF HYDROGEN IN THE WELDING OF TITANIUM

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 20-23
manuscript received 5 Jul 78

ABDULAKH, V. M., SHEVELVE, A. D., engineers, DEMCHENKO, V. F., Candidate of Physical and Mathematical Sciences, and ZAMKOV, V. N., Candidate of Technical Sciences, Institute of Electric Welding imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] A theoretical analysis is made of the kinetics of development of concentration inhomogeneity of hydrogen in the heat-affected zone during the electron-beam welding of titanium, and the results are compared with experimental data. It is assumed that hydrogen concentration is redistributed solely by thermal diffusion in a direction determined by the negative activation energy of the process of dissolution of hydrogen in titanium. The analysis is based on derivation and numerical solution of a system of two equations: an equation of olecular diffusion with a thermal gradient term, and an equation of heat propagation during welding of a plate by a nigh-power high-speed linear source. The influence of the liquid phase on mass transfer in the metal is disregarded, and the diffusion equation is solved for the solid phase only. The changes in solubility and diffusion coefficient of hydrogen in connection with the $\beta \rightarrow \alpha$ phase transformation are disregarded, and the redistribution of the gas is considered in the β-titanium. A comparison of theoretical and experimental results shows that the development of inhomogeneity of hydrogen concentration cannot be attributed to thermal diffusion processes alone. Apparently a decisive role is also played by heterodiffusion and the stressed state in the heat-affected zone. Figures 3; references 6: all Russian.
[94-6610]

UDC 621.791.4:539.378.3:669.295

DIFFUSION BONDING OF T-CONNECTIONS OF VT6 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 10-12

LAVROV, B. A., KARAKOZOV, E. S., TERNOVSKIY, A. P., VIGDORCHIK, S. A., PETROSYAN, V. A., REZNICHENKO, G. I. and ROSTKOVSKIY, I. G.

[Abstract] Techniques of the diffusion bonding (DB) of T-connections of VT6 titanium alloy T-beams were investigated on 3-mm-thick sheet specimens measuring 40 x 30 mm in area that had been diffusion bonded in a vacuum chamber ($7 \cdot 10^{-5}$-$2 \cdot 10^{-5}$ mm Hg). The optimal DB conditions were found to be: temperature T = 950° C, pressure P = 0.2 kg/mm^2, and time t = 60 min. Cyclic fracture strength tests and metallographic analysis showed that the principal cause of fracture is the presence of an acute stress concentrator of the form of a notch generated by local deformation of fibers of the material of the T-flange. This concentrator was then eliminated by means of capillary filling with molten metal (solder) as well as through partial melting by means of argon-arc welding. As a result the fracture strength of the joints was increased to 1500 from 140 load cycles. Further experiments, which included the placement of an insert in the joint zone with an object of optimally redistributing the welding pressure, and the cold working of the capillary-filling area, resulted in increasing the fracture strength of the joints to 30,000 cycles (σ_{max} = 42 kg/mm^2, σ_{min} = 0.15 kg/mm^2). Figures 5; references 2: 1 Russian, 1 Western.

UDC 621.791.72.01

IMPROVING THE PROPERTIES OF VT20 ALLOY WELDMENTS THROUGH LOCAL ELECTRON-BEAM HEAT TREATMENT

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 7-8

LYSENKOV, YU. T., VLASOV, G. A. and OVCHINNIKOV, V. V.

[Abstract] The effect of local electron-beam annealing on the properties of welded joints of VT20 titanium alloy produced by the electron-beam welding method was investigated. The experiments were performed on 13-mm-thick specimens of annealed sheet (200 x 100 mm in area each) that had been butt-welded with the aid of the ELU-5 electron beam rig. The resulting weldments were, following their cooling to 25° C, subjected to local heat treatment (annealing at 750-800° C for 3-40 min) by means of an unfocused electron beam moving along the joint. The degree of defocusing and the current intensity of the beam were so selected as to avert fusion of the joint. Subsequent tests revealed that, compared with weldments

not subjected to such heat treatment (impact strength 45% of that of the base material), the heat-treated weldments display an impact strength roughly equal to that of the base material. Moreover, impact strength is still further increased (to 6.2-7.1 kg·m/cm^2) when the locally heat treated weldments are subjected to the so-called "cosmetic operation" consisting in melting the joint of one-third of its depth with the aid of an unfocused electron beam, which results in the formation of a fine-grained structure of the joint. References 6: 5 Russian, 1 Western. [130-1386]

UDC 621.791.72:669.293.5+669.14.018.8

UNFOCUSED ELECTRON BEAM WELDING OF NIOBIUM ALLOYS TO STAINLESS STEEL

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 14-15

KRUTOGOLOVOV, N. P., D'YACHENKO, V. V., SIVOV, YE. N., FROLOV, N. G. and MONAKOV, A. M., Moscow Aviation Technological Institute imeni K. E. Tsiolkovsky

[Abstract] If niobium alloys are to be joined to stainless steel without the formation of intermetallic compounds, the temperature of niobium in the zone of contact with stainless steel should be 1400-1480° C, with the time of contact being a function of the volume of material and area of contact. This can be assured by unfocused electron beam welding with a low accelerating voltage (8-12 kv). Proceeding from this premise, VN2AE and ELN1 niobium alloys were welded to 12Kh18N10T stainless steel to obtain welded joints 2 to 5 mm thick. The optimal formation of the joint was achieved when the heating spot was 10-12 mm in diameter. The distribution of the components of steel and niobium in the fusion zone was found to be constant and to correspond to the eutectic composition (in %): 10-12 Nb, 9-10 Ni, 15 Cr, 64 Fe. The strength of the resulting weldments at room temperature was found to be a function of the strength of the niobium alloy used. Figures 3; references 3: all Russsan. [130-1386]

UDC 621.791.72:621.373.826

LASER BEAM WELDING OF VNZh7-3 ALLOY TO VT1-0 TITANIUM

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 4, 1980 pp 3-4

BARANOV, M. S., VOSHCHINSKIY, M. L., FEDOROV, P. M., SHILOV, I. F. and ZYTNER, G. D.

[Abstract] In view of the difference in properties between VNZh7-3 sintered alloy (90% W, 6.8-7.4% Ni and 3-3.4% Fe) and VT1-0 titanium (99.2% Ti), it is not feasible to weld them together by any heat source requiring prolonged heating. On the other hand, welding techniques serving to assure a high thermal energy density within a small volume of metal over a brief period of time are suitable for this purpsoe. In this connection, the applicability of argon-shielded laser-beam welding was investigated. The experiments were performed on plane specimens (5.0 x 0.5 mm in area) with the aid of a DVANT-10 laser. In view of the smaller depth of fusion and weld-spot diameter that could be achieved in VNZh7-3 alloy compared with VT1-0 titanium, it was decided to shift the laser beam in the direction of the base metal 0.12 mm away from the joint-line, thus assuring a symmetrical weld spot, and a balanced depth of fusion. The edge joints of VNZh7-3 alloy and VT1-0 titanium proved to have a satisfactory shear strength (32.7-40.1 kg/mm^2). The strength of the weldment exceeded the strength of VT1-0 titanium alone, owing to the formation, in the welded joint, of a new alloy containing components from VNZh7-3 alloy. Figures 5; references 2: both Russian.
[130-1386]

EXCESSIVE CONSUMPTION OF METAL

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 95, 25 Apr 80 p 1

[Article by V. Selyunin, economics reviewer of "Sotsialisticheskaya Industriya"]

[Text] The basic directions for developing the national economy in the years 1976--1980 were to assure a savings in rolled steel used for machine building and metal working of 14--16 percent. Judging from preliminary data for the four years, the outcome is satisfactory enough. If we consider the current plan we can also make a conclusion for the five-year plan as a whole: the real savings will be close to the upper limit designated by the 25th CPSU Congress, that is, 16 percent.

I shall mention one case in particular: mechanical engineers achieve this success under conditions which are more complex than was assumed. For achieving economies in rolled steel products depends not only on those who use it. There was a plan to save 5--6 million tons throughout the national economy in 1980 by improving the quality and expanding the varieties of metals available. This result should have been first revealed in machine building. However, it turned out otherwise. The metallurgy industry is slowly reorganizing for the production of economical shapes. About 80--95 percent of the requests for their manufacture are fulfilled. Of 140 effective rolled products, which should be produced for the needs of the machine building industry, more than one-half have not yet been produced. On the whole, savings due to improved metal quality is only about 60 percent of the amount assigned by the five-year plan.

Of cource, in such conditions it was difficult for the designers to reduce the weight of machines. But nevertheless their achievements were not insignificnt. For the years 1971--1978 the unit metal consumption for turbines and locomotives was reduced by 20--30 percent, for automobiles it was 16.5--20 percent, for power trains, metallurgical installations and diesels, it was 15--17 percent, and for tractors it was 9.5 percent. But the consumption of metal for many kinds of machines is greater in the Soviet Union than in the USA. Bridge cranes, automobiles, forging and stamping equipment, excavators, locomotives, and refrigeration units, in particular, are greater consumers of metal.

The main reason for this lag is inferiority of the grades, and the inadequate strength of the rolled product. For when the needed grade is not available a larger piece is used. Thus, such irrational replacements have used up more than 550,000 tons of rolled products in only 3 years.

As the hopes for reorganizing metallurgy were not completely carried out, it became necessary to search for other resources. About 80 percent of the entire savings in rolled products will be obtained in the five-year plan by improvements in production technology and machine designs. These areas will ensure compensation for overexpenditure caused by the lack of the required kinds of metals and in the final analysis will allow us to introduce one of the most important parts of the 10th Five-Year Plan.

It is relevant to explain at this point how a savings can disappear. The consumption of materials for the annual program is determined in practice according to the norms of the preceding year. Resources are not given out in the full amount, but with some reduction--this will be the program based on a savings. At first glance an executive has nowhere to turn--he is obligated to establish new, more strict rates of consumption and adhere to them; otherwise he has no way to fulfill his responsibilities in production. But here in front of me is a preliminary report from the past year. Enterprises of USSR Minenergo [Ministry of Power and Electrification], according to the plan, were supposed to fulfill their program while using 10,000 tons less of rolled products than would have been necessary for putting out the same amount of gross according to the consumption norms of 1978. According to the report the savings amounted to 12,700 tons. Excellent? Not entirely. If we compare the report not with the norm, but with the actual expenditure for 1978, we discover: for each unit of goods produced, the industry consumed on the average more metal in the year earlier and as a result it required 5,400 tons more in order to fulfill the program. Where then, one might ask, is the savings? It exists only in the report and in reality resources were used more extravagantly than a year ago.

The reason for this deception, I suppose, is understandable: the norms for 1978, which were taken as the base for the future, were much increased, they were easily covered up at the right time, and then it was possible to increase the unit consumption of metal without fear--the report shows a savings all the same.

How typical is such a situation? I examined data for 28 branches of the industry--the savings in 1979 for 18 of them as against the actual unit consumption achieved in the preceding year, turned out to be less than against the norms, and in 5 branches the unit consumptions were even greater. Of course, it would be better to make assignments for the branches and enterprises in the form of a reduction in the unit consumption of resources in comparison with the actual achievements. Unfortunately, this is impossible--at the moment next year's actual unit consumption is

in the galley-proof stage, and is still unknown, and it won't be known until much later; the planners must use as their reference unreliable existing norms. In other words, flaws in the accepted index of savings in the annual planning are not easy to get rid of.

However, they are quite noticeable in evaluating the five-year plan of the branches. We shall compare 2 branches--heavy machine building and machine tool manufacture. The former will lower the current unit consumption of rolled products per unit of goods as against the base norms for 1975 by 13.7 percent, and the latter will reduce it by 19.4 percent. Which one is more successful? It would seem that the figures speak for themselves. In actuality, among 11 leading machine building branches of Mintyazhmash [Ministry of Heavy Machine Building] the reduction in rolled product consompution was the most modest, but in Minstankoprom [Ministry of Machine Tool Manufacture] there was almost a record reduction.

However, it is easy to realize that the result depends greatly on how rigid the norms were in the 1975 base year--for the branches which use metal extravagantly at that time, it would be easier to show high rates of savings. Is there an indicator which will balance out the starting difference? I think there is. This would be the coefficient of metal use. In heavy machine building it is currently 0.79--that is, 79 percent of the metal goes into the final product and the remainder into waste products. With such an estimate Minyazhmash is going from next-to-last to first position among the leading branches of machine building--the amounts of waste here are least. On the other hand, Minstankoprom is dropping from a high second position to last--in its enterprises only 61 percent of the metal now ends up in the final product.

The coefficient of metal use more objectively reflects the true picture. On what basis is such a judgement made? Specialists of the state supply inspection board for checking the use of material resources are constantly monitoring the situation in the branches. After having studied their reports for several years, I attempted to compare them to statistical accounts. And almost always it turned out in the following manner: whoever had the greatest statistical savings as against consumption norms, that one was found to have greatest extravagance. However, it was worthwhile to combine the results of inspections with the coefficients of metal use, which put everything in their proper positions: where the coefficient is lower, there greater reserves were found.

This was no accident: the coefficient detects the savings factors, which depend basically on the producers themselves, and not the external circumstances or on the agility of those who make the standards. Beginning in 1980 this indicator will be included in the state plan. Currently it is being raised in the machine building branches from 0.728 to 0.735 and is approaching the USA level (there it is 0.75). The possibilities it holds are enormous. We shall examine several reserves.

In the automobile industry the coefficient of metal use is much lower than the average level and it even fell from that level in the decade from 0.7 to 0.68. What's the matter? The administrative staff of the branch has not lowered the consumption norms for a number of articles for several years, and in general they don't regulate them at all. Thus, for five basic models of "Gaz" trucks, of which more than one-half million tons of rolled products are consumed yearly, Minavtoprom [Ministry of the Automobile Industry] did not approve the norms. Taking advantage of this, the association "AvtoGAZ" increased them in comparison with what had been achieved. And it did no good to add postscripts. For example, the VPO "Soyuzpodshipnik", increasing its reference norms by backdating, showed 1,752 tons of additional savings in its report. Yet for the year 1978 alone the postscript showed an overall savings for the branch of 33,200 tons--it was only because of the vigilance of the inspectors that this figure was excluded from the state report.

The inspectors also detected large reserves of technological capacity. The branch plan section, which oversees the introduction of low-waste technologies, is non-specific. In the best case it provides only 15 percent of the planned economy of metal (on the average for machine building this area adds only 40% of the entire savings). The Gor'kiy Automobile Plant similarly loses metal as waste products, even though it does so on a technically legal basis. One-half of all forged and stamped pieces are manufactured here with impossible tolerances--up to 75 percent of the metal ends up as waste products. During the production of parts by the cutting method in mechanical shops up to 50,000 tons of rolled products annually are turned into shavings.

Perhaps other methods of machining cannot be used? This is not so. Imported cold-forging automatic devices are less than half loaded at the plant. And this is not all. At the Ural Automobile Plant such automatic devices are utilized to only 15 percent capacity and one of them has been standing idle for three years. The new forging installation of UAZ [Ural Automobile Plant], which is rigged with advanced equipment, is operating at half-capacity.

For three years machine building enterprises which are lagging behind have consumed 824,000 tons of rolled products above their norms--these losses were covered by a savings due to the efforts of economical enterprises, and the overall result turned out to be satisfactory. But the total amount of losses of almost 250,000 tons were the "contribution" of Minavtoprom. The automobile engineers, together with enterprises of Minsel'khozmash [Ministry of Agricultural Machine Construction] overconsumed more than 450,000 tons, that is, much more than all other machine building enterprises.

The coefficient of metal use is also falling at Minenergomash, which again is not explained by the obsolescence of production technology. Even by such an obsolescent method as free forging one and half times more

intermediate products are manufactured in the branch and this is the average for machine building, but the amount of hot stamping here is only one-fifth. As a result, they consume 96 kilograms of metal more here per ton of forged and stamped products. Suppliers of the enterprises have been able to establish consumption norms which exceed the level achieved so far. For example, the Taganrog "Krasnyy kotel'shchik" received more than 5,000 tons of surplus metal in one year. The warehouses are bursting from the unnecessary abundance. The Khar'kov Turbine Plant has accumulated 11 times more large-diameter tubing than it needs, and the Belgorod Power Machine Building Plant has accumulated 61 times the norm of sheet stainless steel after many years of operation. Cases have been found where high-grade products that haven't been used for a long time at plants of Minenergomash do not show up in the state report--they are not counted among the assets, but they are in the warehouse.

Some plants are profiting by such goings on. The Khar'kov Turbine Plant turns into scrap metal sheet waste products with lengths up to one and a half meters and widths up to 71 centimeters. Metal has become its means of exchange: enterprises exchange it even for vacation resort passes, and, for example, the Izhorskiy Plant paid for the lease on a gymnasium with rolled products. Inspectors pointed out such facts several years ago. What has been done about it at the ministry? Now there is twice as much rolled steel goods at these plants as was detected during the previous inspection.

Sometimes such deceptive practices are committed under pressure from local authorities. The chairman of Kemerovskiy Urban Council G. Veselov "taxed" enterprises in the city for goods produced by them: he made them set aside metal for a fence around a park. An example of bad taste. But hundreds of tons of rolled product were already wasted. Sharpened spikes 3 meters high, forged vignettes, ornaments--evidently in Kemerov they've decided to "reweave" the outstanding lattice work of Leningrad Summer Home. You must be aware of this.

The current year a large increase in production of ready-made rolled steel products is not foreseen, even though it is needed--we are already in first place in the world for output of these rolled steel products. If we are also to become the most economical in the world, then problems of metal shortage will have to be removed from the agenda.
[140-9424]

9424
CSO: 1842

THE FUNCTIONS OF IGNEOUS MATTER

Moscow IZVESTIYA in Russian No 107, 7 May 1980 p 3

[Article by Academician B. Kadomtsev]

[Text] Plasma is familiar to everyone from the brightly glowing lights of modern advertising displays. The stars and the galaxy consist of plasma--ionized gas. Many scientific collectives are laboring persistently on study of the fine physical processes taking place in plasma. Because of this, plasma is finding ever broader fields of use in modern scientific research and production processes. Here are are only a few examples.

The technique of plasma coating of metal products with corrosion-resistant or strong and wear-resistant protective films, developed at the Scientific Production Association Tulachermet under the supervision of Corresponding Member of the USSR Academy of Sciences A. Manokhin, made plasmatrons a desired production participant in modern shops of the metal-working industry. And the technique of applying wear-resistant coatings, which permits a several-fold increase of the operating life of metal-cutting tools and machine parts, was developed at the Khar'kov Physicotechnical Institute under the supervision of Corresponding Member of the Ukrainian SSR Academy of Sciences V. Toloka. The "Bulat" installations developed at this institute have achieved wide introduction in the machine tool and other sectors of the country's national economy.

The new step in study of the underlying principles of plasma physics was begun by research in controlled thermonuclear fusion. The main problem of this research is to produce a plasma at a temperature of tens of millions of degrees and to hold it in this state for a time sufficient for thermonuclear reactions to occur. The principles of the processes occurring in a plasma had to be studied in more detail and a number of methods had to be tested to achieve this goal. Not all attempts were successful, but they considerably enriched our knowledge and some of them revealed new possibilities for solving practical problems.

Specifically, while conducting exploratory research on controlled thermonuclear fusion at the Institute of Atomic Energy imeni I. V. Kurchatov,

N. Filippov and colleagues discovered a new, unusual type of powerful electric discharge at the end of the 1960s, which they called a plasma focus. The discharge occurs in a special cylindrical copper chamber. An insulator on whose inner side is attached an anode, while the cathode is the chamber itself, was installed in the same chamber. A plasma envelope, which is then rapidly compressed by a magnetic field, working off in its path all gas, usually deuterium, is generated upon discharge of capacitor banks near the insulator walls. A very dense plasma bunch is generated as a result of the rapid compression of the plasma near the anode.

This bunch exists for only one 10-millionth of a second, but it manages to emit a very large number of thermonuclear neutrons at 15-30 million degrees during this time. The plasma focus, as a very powerful short-pulse neutron source, began to find various applications in modern scientific research. It was shown in subsequent experiments that the plasma focus in specific modes becomes a powerful X-ray source.

Small chambers to create a plasma focus using compact power supply systems were developed in this direction under the supervision of V. Chernyshev and N. Makeyev. These devices are beginning to find various applications in technology and scientific research, for oil prospecting, development of integrated microcircuits in electronics and in medical and biological research.

So-called plasma beam discharges were investigated in detail during study of the instabilities and collective phenomena in a plasma in a magnetic field. It turned out that these discharges make it possible to develop new plasma production processes.

As was proven by Doctor of Physicomathematical Sciences A. Ivanov and colleagues, a plasma beam discharge can be used to create plasma formations similar to a wide band. This band is formed by the shape of the electric beam shot from an electron gun along a magnetic field in a low-pressure chamber. The electron gun is similar to those used in ordinary television sets, but the cathode in it is made in the form of an elongated thread rather than in the form of a point. The plasma with electron temperature of 20,000-40,000 degrees, formed due to the effect of the beam, is very convenient for conducting plasma-chemical reactions when a wide gas flow passes through the plasma band. The area of the band may reach tens of square decimeters. It can be rolled into a cylinder if the cathode is made in the shape of a ring. In this case the gas can be admitted inside the cylinder, gathering the reaction byproducts beyond its limits. Band discharges may find wide application for creation of plasma-chemical production processes and plasma technology for the electronics industry.

Stationary plasma sources, developed by Doctor of Physicomathematical Sciences A. Morozov and colleagues, may also be used for various production processes. These devices were initially developed as low-thrust space plasma engines. Externally, this engine looks like a cylinder several

centimeters in diameter. A plasma jet travelling at a speed of tens of kilometers per second is generated in it. The jet has low density and can be used for "soft" treatment of materials--cleaning the surfaces of impurities, etching, polishing and precision machining of surfaces.

It is difficult to relate all the possibilities of using plasma physics in modern production processes in a brief story. It is important to emphasize that many practical applications occur from purely fundamental research. [136-6521]

6521
CSO: 1842

CONCERNING THE PROBLEM OF THE MECHANISM OF HARDENING OF A MATERIAL UNDER THE ACTION OF A CONTINUOUS LASER BEAM

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 1(91), 1980 pp 35-39

KOVALENKO, V. S., Kiev, ENAMI, K., ARATA, YE. and NENNO, S., Osaka, Japan

[Abstract] The paper gives the results of electron microcopes studies of the structure of aluminum specimens exposed to continuous laser radiation. A CO_2 continuous-wave laser emitting with power of 1.5 kW on a wavelength of 10.6 μm was the source of radiation. The laser beam was focused on the specimen by a zinc selenide lens. The workpiece was displaced at rates from 100 to 10,000 mm/min. To prevent melting or vaporization of the workpiece, the specimen was moved away from the focal plane by an experimentally determined distance. Measurements of microhardness showed that the heat-affected zone is made up of three regions in which hardness is usually different from that of the base material. The main zone located beyond the visible track of laser treatment has a very high average hardness of 39.5 kgf/mm^2, that reaches 44.5 kgf/mm^2 in some regions. Between this region and the visible laser track is a very narrow region where the hardness is even lower than in the base metal (30.8 kgf/mm^2, and even as low as 28.2 kgf/mm^2). The third region is within the limits of the visible track, where the hardness ranges from 32.5 to 36.5 kgf/mm^2. Electron microscope analysis shows that the microstructure also differs in these three regions. The hardest region has a dislocation structure, the softest is a dislocation-free region of dynamic recovery, and the intermediate region in the visible track shows dislocation loops with lower density than in the hardest region. The distribution of dislocations is attributed to shock wave motion. Figures 3, references 16: 1 Russian, 9 Western.
[127-6610]

UDC 539.4

RESULTS OF HEAT CYCLING LIFE TESTS PERFORMED ON HEAT RESISTANT MATERIALS UNDER ASYMMETRIC THERMOMECHANICAL LOADS

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 49-53 manuscript received 12 Jun 79

LOZITSKIY, L. P., VETROV, A. I. and KOVESHNIKOV, N.A., Kiev Institute of Civil Aviation Engineers, Kiev

[Abstract] A study was made to determine the life characteristics of heat resistant alloy steels (ZhS6K, ZhS6U, EI437B, EP99vd, Kh18N10) under compound static and cyclic thermomechanical loads. Standard specimens

were tested with zero, variable, or constant static load at several levels ranging from 50 to 450 MPa and with cyclic temperature swings ranging from 100-750° C to 350-1000° C. A statistical analysis of the results reveals a log normal distribution of the number of cycles till fracture and a linear dependence of this number (Log N) on the stress. A further mathematical analysis leads to a fourth-degree equation in log N which involves all parameters and with which the median life can be calculated. Figures 4; references 4: all Russian.
[139-2415]

UDC 620.178.3:539.43

ON THE PROBABILISTIC-STATISTICAL PROCESSING OF FATIGUE TEST RESULTS PERTAINING TO AN ALUMINUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 4, Apr 80 pp 45-48 manuscript received 28 May 78

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[Abstract] Fatigue tests of aluminum alloys usually yield results with a wide spread of values. Here an analytical method of evaluating the life and the endurance limit of an aluminum alloy is proposed which does not require plotting of fatigue curves. Accordingly, the stress-cycle test data in semilog coordinates are approximated by a second-degree polynomial with coefficients calculated by the method of least squares. A correlation has been found to exist between the statistical parameters of test data distribution, including probability of fracture, and the fatigue characteristics of the D16 aluminum alloy. An evaluation of this material by this method, based on a 50% probability of fracture, yields results in satisfactory agreement with those obtained by other methods. Figures 1; references 6: all Russian.
[139-2415]

UDC 669.017

ANALYSIS OF RADIATION RESISTANCE OF METALLIZED POLYMER FILMS EXPOSED TO 1.06- AND 10.6-MICRON WAVELENGTH LASER RADIATION

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 3-6 manuscript received 4 Jun 78

VOLYAK, T. B., GALKINA, N. S., KARLOVA, Ye. k., KRASYUK, I. K., PASHININ, P. P., TROFIMOVA, A. A. and SHARAFUTDINOVA, D. E., Moscow

[Abstract] The destruction thresholds of different thicknesses of metallized aluminum, copper, nickel and gold films, applied on polymer substrates and the transmission coefficients of specimens exposed to 1.06- and 10.6-micron laser radiation are measured to find thin metallized films that are promising materials in laser technology for shortening CO_2 laser pulses. The study discloses that gold films on polyethylene terephthalate (PETP) and copper films on teflon are most resistant to 10.6-micron wavelength laser radiation because these metals have higher reflectivity than nickel and aluminum and are the best reflective surfaces on both wavelengths. The examined films can be used in laser systems in place of solid metal mirrors. Figures 2; references 10: 8 Russian, 2 Western.
[124-7872]

UDC 549.2:621.039.61

PHYSICOCHEMICAL PROPERTIES OF TITANIUM CARBONITRIDES SYNTHESIZED IN COLD PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 147-148 manuscript received 16 Dec 77

TROITSKIY, V. N. and GREBTSOV, B. M., Moscow

[Abstract] The feasibility of producing a continuous series of anisosubstituted solid solutions of titanium carbonitrides with considerable excess nitrogen is examined. Experiments are conducted on the thermal decomposition of hydrocarbons in a stream of SHF discharge nitrogen plasma to determine the conditions of elemental carbon production. Analyses of the reaction products show that free carbon is a condensed phase in the form of highly disperse powder. The combined hydrogen reduction of $TiCl_4$ and thermal decomposition of hydrocarbons in nitrogen plasma produced titanium carbonitrides which comprise a series of single-phase solid solutions of carbon in titanium nitride with an NaCl structure and general formula TiC_xN_y. The concentration of titanium, nitrogen and total carbon is determined by chemical analysis of the powders. The amount of free

carbon is determined by dissolving the powders in a mixture of nitric and hydrochloric acids. The lattice period of the insoluble precipitate is plotted as a function of the mole composition of the carbonitride phase. Carbonitrides containing more than 8% bonded carbon have more free carbon, the closer the composition gets to titanium carbide. Figures 1; references 8: 6 Russian, 2 Western.
[124-7872]

UDC 535.211:536.21

A WAY TO DETERMINE TEMPERATURE FIELDS AND EFFECTIVE ABSORPTION COEFFICIENT DURING SURFACE FINISHING OF METAL WITH SCANNING LASER BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 7-10 manuscript received 11 Jan 78

KORNEYEV, V. V. and YAVOKHIN, A. N., Moscow

[Abstract] Different methods are examined for finding the absorption coefficient, necessary for determining the temperature distribution during heat treatment of metal surfaces with scanning continuous laser beam for the purpose of hardening steel and iron. The direct calorimetric determination of the effective absorption coefficient on the basis of the ratio of the total absorbed energy to the incident energy is found to offer great advantages in terms of simplicity and precision, and the temperature distribution and temperature field dynamics in a specimen can be found in consideration of temperature errors. Figures 4; references 5: 3 Russian, 2 Western.
[124-7872]

UDC 669.15-194.56; 539.56:539.1.043

RADIATION DAMAGE OF CHROMIUM NICKEL AUSTENITE STEEL BY 1-MeV ELECTRONS IN A HIGH-VOLTAGE ELECTRON MICROSCOPE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980 pp 11-15 manuscript received 17 Sep 79

ORLOVA, A., CHADEK, I., LAZORENKO, V. M. and IVANOV, L. I., Brno Czechoslovakia; Moscow

[Abstract] The radiation resistance of 1Kh18N9T austenite stainless steel as a candidate for the first wall of a first-generation magnetic confinement thermonuclear fusion reactor is analyzed and data are presented on the physics of the formation and spreading of radiation defects in

gamma-solid solution due to electron irradiation at the energy where only point radiation defects occur. Radiation damage in commercial austenite stainless steel is examined in situ at an energy of 1 MeV in a high-voltage electron microscope. Vacuum annealed water-quenched steel foils are used for analyzing radiation damage at 420° C. The kinds of damage that occur under these conditions are described and the results of the analyses indicate that the dislocation loops and pores that occur can cause low-temperature radiation embrittlement of the investigated steel. Figures 3; references 10: all Western.
[124-7872]

UDC 669.1:539.4

CRYSTALLIZATION FEATURES OF NICKEL AND NICKEL-BORON ALLOY FILMS ON REINFORCING FIBERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 128-131 manuscript received 22 Nov 78

GOL'DINER, M. G., Kishinev

[Abstract] The features of the chemical crystallization of nickel and of its alloys with boron on carbon fibers and filamentary sapphire crystals are analyzed to determine the influence of surface finish on the structure of films that form on them and on the initial stages of crystallization. The carbon fiber and filamentary sapphire crystals are sensitized and activated to impart catalytic properties, leading to the formation of palladium islands that initiate decomposition of the solution. Sodium boron hydride as a reducing agent causes the joint precipitation of nickel and boron. Films of the alloys are subjected to x-ray diffraction analysis. The results show that the formation of nuclei and sequential activation of active centers, prepared by pretreating the fibers, and the morphologic and structural evolution of the growing film are related to the step by step participation of the components of the alloys in the evolution process. Figures 2; references 5: all Russian.
[124-7872]

UDC 621.315.592.002

ANALYSIS OF ETCHING OF SILICON DIOXIDE THERMAL FILMS BY FREON ION BEAM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 25-27 manuscript received 11 Apr 79

ANTIPOV, A. N., POZHIDAYEV, Ye. D., IVANOVSKIY, G. F. and TROSHINA, G. S., Moscow

[Abstract] The freon ion etching of a thin silicon dioxide film, grown on the surface of monocrystalline silicon, is analyzed by IR-spectroscopy as a promising process that does not require the use of liquid reagents for precision transfer of images of integrated circuits to substrates. The film is etched in stages with a freon-218 ion beam at a fixed etching rate. The study indicates that the etching that occurs is primarily of a chemical nature and that organic contaminants do not precipitate on the etched surface when freon ions are used. Figures 2; references 5: 4 Russian, 1 Western.
[124-7872]

UDC 539.216.2

INFLUENCE OF IONIZATION AND ENERGY OF PLASMA PARTICLES ON STRUCTURE AND PROPERTIES OF ALUMINUM FILMS ON SILICON SUBSTRATES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, 1980
pp 66-72 manuscript received 2 Jan 79

[Abstract] Comparative analyses are conducted on the effect of electron beam plasma sputtering and thermal sputtering on the structure of aluminum thin films and the strength of their bond with monocrystalline silicon substrates in connection with the increasing use of various methods of vacuum precipitation of thin films and coatings from ionized vapor. Films are sputtered onto 250-micron-thick silicon chips, oriented in the (111) plane. After mechanical processing and polishing, the chips are chemically polished in a mixture of hydrofluoric and nitric acids to remove the damaged surface layer and are etched again in 20% hydrofluoric acid priod to sputtering. Examination of the surfaces shows that electron beam plasma sputtering produces a stronger film-substrate bond than thermal sputtering because in ion bombardment most of the energy of the ions is converted to heat due to deceleration of the ions in the near-surface layers of the substrate. The films also have a more equilibrium structure and greater thermal stability and considerably less Al-Si contact resistance. The equipibrium growth of films by electron beam sputtering produces equiaxial grains of uniform size, and the application of negative bias potential to the substrate reduces the grain size in the film. Figures 5; references 16: 5 Russian, 11 Western.
[124-7872]

UDC 178:539.38

METHOD OF EVALUATING AND PREDICTING THE LIMITING STATE OF HEAT RESISTANT ALLOYS UNDER AN ASYMMETRIC MULTICYCLE LOAD

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 79 pp 13-18 manuscript received 28 Mar 78

ISHCHENKO, I. I., GOLUB, V. P., SINAYSKIY, B. N. and POGREBNYAK, A. D., Institute of Mechanics, Academy of Sciences UkrSSR, Kiev

[Abstract] A method is proposed for evaluating the time to crack formation as well as the rate of crack development under conditions of cyclic fatigue and creep for a moderate increase in temperature. Using EI867 and VZhL12U alloys at 900 and 1000° C, respectively, for periods of 10 and 100 hours, experimental data were obtained which make it possible to show that the principles of damage accumulation under these conditions differ considerably in each of the two stages of fracture. In the stage of crack formation a negative nonlinear interaction of static and fatigue damage can be observed while in the stage of crack development this interaction is absent and the rate of crack growth for the combined action of fatigue and creep can be determined by a simple summation of crack growth rate under conditions of each of these forms of failure. Figures 3; references 15: 10 Russian, 5 Western.
[87-6368]

CSO: 1842

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